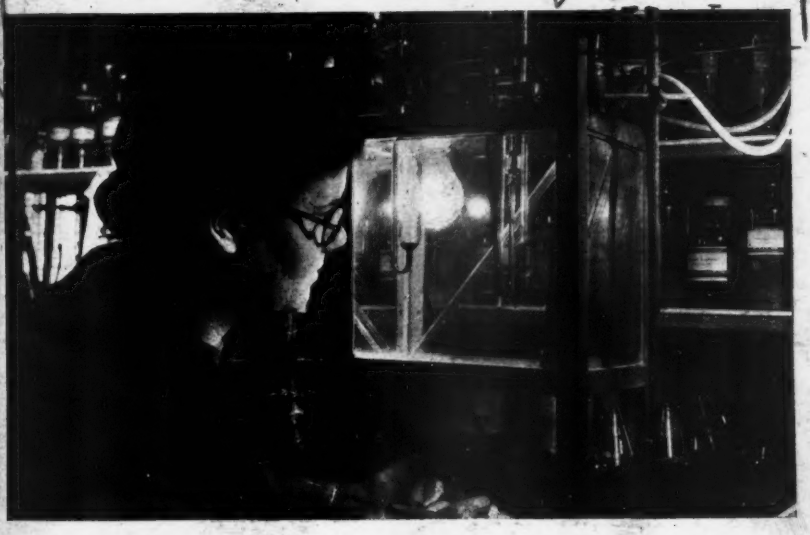
ULY, 1945 TECHNOLOGY DEPT. ONE SHILLING & SIXPENCE

Plastics



Viscosity Test

Were it not for the knowledge of how molecules form into groups, polythene—a remarkable new substance used almost exclusively by the services for such purposes as high frequency radio—would still be one of nature's secrets. It is the structure of the polymer which determines the ultimate qualities of polythene, and this structure is analysed by measuring the viscosity, or the rate of flow of a solution of polymer, in a viscometer similar to that illustrated. The viscosity of the solution tells the chemist much that he needs to know about plastic materials and how they will behave when put into use. In I.C.I. Plastics factories the Viscometer is in constant use.

ICI

The Tortoise was once on the 'Rim' of things

So far as our knowledge goes—and it is not profound—the tortoise that beat the hare did not belong to the same species as the one which is bound to lose the race in the supply of frames for spectacles, rims for mirrors and backs for brushes. Unfortunate members of the marine branch of the family who find themselves 'in the soup' so far as commercial prospects are concerned have, at least, the consolation of saving their skins. Plastics are so much more tractable than tortoise-shell and their use not nearly so tortuous.

We at Erinoid, if not exactly learned on tortoises are, at any rate, erudite in regard to the technology of plastics—a fact which enables us to place a wealth of experience at the disposal of British manufacturers.

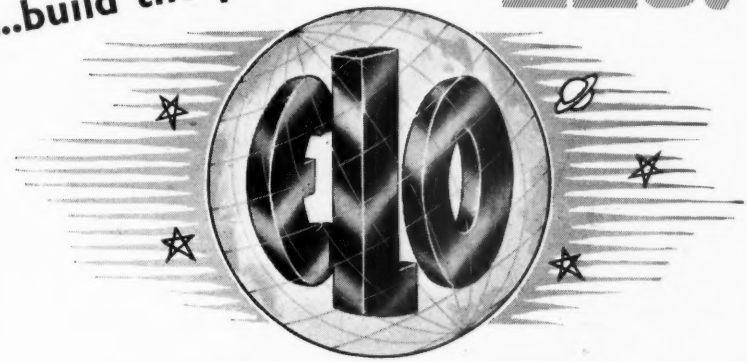
Erinoid LIMITED

MANUFACTURERS OF MODERN PLASTICS MATERIALS

CELLULOSE ACETATES • PHENOLIC RESINS • POLYSTYRENE
LAMINATED MATERIALS • VINYL RESINS • CASEIN MATERIALS

ERINOID LIMITED, LIGHTPILL MILLS, STROUD, GLOUCESTERSHIRE

...build the post-war world of ELO?



To realise one's limitations...

when one has enthusiasm is often difficult—particularly if, having pioneered new paths and, after arduous effort, one has found success.

We at Birkbys have phenolic plastics—materials of 1000 uses—to enthuse over; we are also pioneers in plastics, yet we are happy at having shared in telling the world what plastics CANNOT do.

Strings of superlatives have been used about plastics by sensationalist journalism, but we hope the possibilities of plastics—the real virtues of ELO—have not been obscured. You just can't build a world of ELO, but you can base post-war production on a sound use of this material . . . why not get to know more about it?

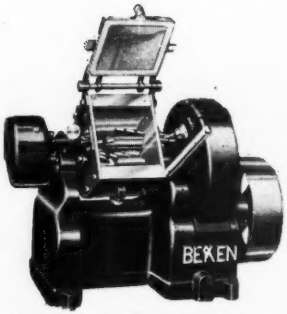
Mouldings, Powders, Resin and Varnish.
For everything electrical and 1,001 other uses.

"The Pioneer elo Plastic"

PLASTICS

Write NOW for information to THE RESEARCH SECTION, BIRKBYS LTD., LIVERSEDGE, YORKS. PHONE HECKMONDWIKE 214

"No stirring tale, this!"



The story of the BEKEN "DUPLEX" Mixer tells of that rare achievement . . . the perfect mix! No longer is it necessary to be content with the customary glorified "stir"; the scientifically designed intermeshing blades of the BEKEN achieve a perfect mix, with the correct proportions of the ingredients . . . however diverse . . . maintained throughout. And it is all done in less time and at lower power cost! There is a BEKEN Mixer to suit every process and any output. Write us on your own mixing problems, and we will tell you the type of machine to do your job better than ever before.

BEKEN DUPLEX MIXERS

Sole Distributors: LAVINO (LONDON) LTD. Tel:— CHAncery 6137/8
103, KINGSWAY, LONDON, W.C.2.

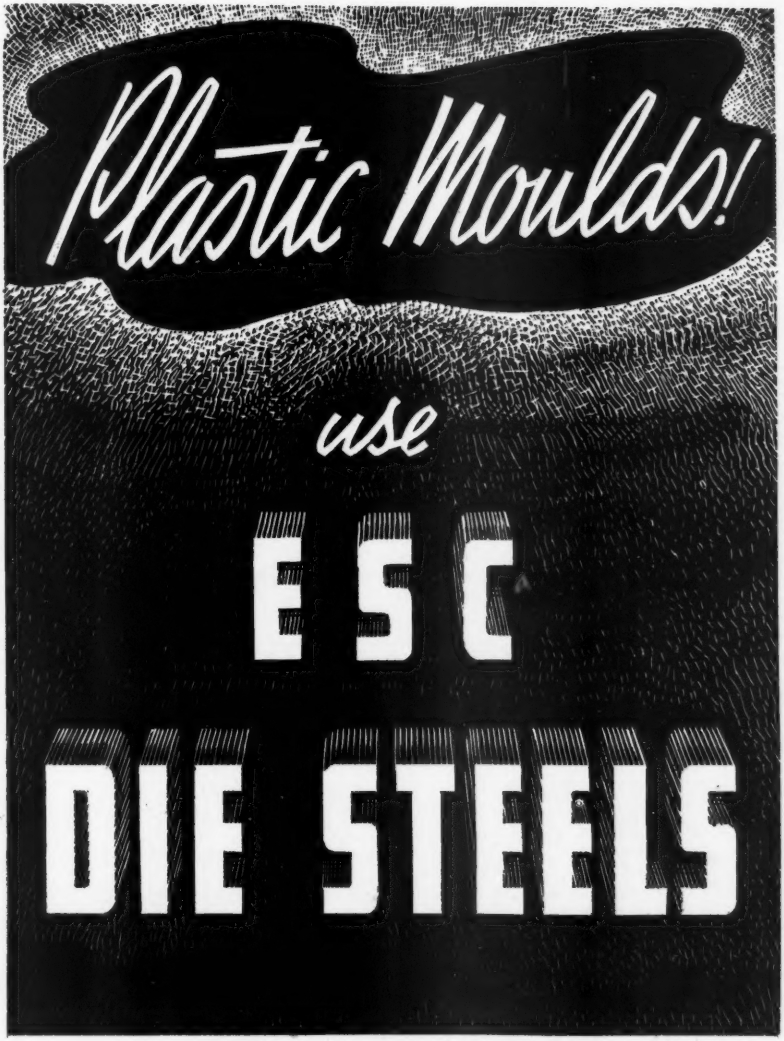
Sole Makers: E. HUNT & CO., LTD.
RIPPLE ROAD, BARKING, ESSEX.

PRESSURE VESSELS
WITH PATENT QUICK OPENING DOORS

for the
PLASTICS
INDUSTRY

STEAM JACKETED PANS, AUTOCLAVES, HEATERS, CONDENSERS, ETC. OF WELDED CONSTRUCTION.

EDWIN DANKS & CO. (OLDBURY) LTD.
OLDBURY, Near BIRMINGHAM Phone: Broadwell 1381 2 3 London Office: 32 FARRINGDON STREET, E.C.4.



ENGLISH STEEL CORPORATION LTD

OPENSHAW WORKS MANCHESTER

A*

'X'=Prefabrication *in POST WAR* everyday Construction

The advantages of using Jicwood 'X' are so many that we can only state briefly a few of its uses. Jicwood 'X', consisting of plywood, plastic or light metal skins permanently bonded to a low density expanded plastic core, offers better thermal insulation than high grade cork; it is vermin and bacteria proof; non-warping and above all, combines great strength and rigidity without framework, yet can be made as light as 0.6 lb. per square foot. Its qualities suggest numerous uses, such as temporary housing (prototypes licensed by M.O.W. are erected), partitions, panelling, doors, flooring, furniture, fixtures; in fact, Jicwood 'X' can be utilised for practically all stressed applications.

Jicwood 'X'

JICWOOD LTD., WEYBRIDGE, SURREY

Telephone: WEYBRIDGE 1600 Telegrams: JICWOOD, WEYBRIDGE

MAXIMUM PRODUCTION DEMANDS

HYGIENIC CLEANLINESS

and

. . . STERNOCLEANSE prevents dermatitis. It keeps your work-people free from industrial skin troubles easily, quickly and economically. STERNOCLEANSE IS NOT A "CLEANSER"—it is an antiseptic emollient cream which is rubbed into the skin before work, forming an imperceptible but impervious "glove."

This effective, persistent barrier between the skin and irritating chemicals, etc., is easily removed by washing with ordinary soap and water, leaving the skin hygienically clean. Neither harsh "cleansers" nor violent scrubbing is needed.

Use Sternocleanse No. 1 for protection against paints, grease, oil, tar, filings, etc.
Use Sternocleanse No. 2 for protection against soluble oils, spirits, chemical and water-wet solutions.

Sternocleanse

SKIN SCREEN AGAINST DERMATITIS

Packed in 12 × 2-lb. tins, 6 × 7-lb. tins. Also in 28-lb. and 1-cwt. kegs.

STERNOL LTD., FINSBURY SQUARE, LONDON, E.C.2

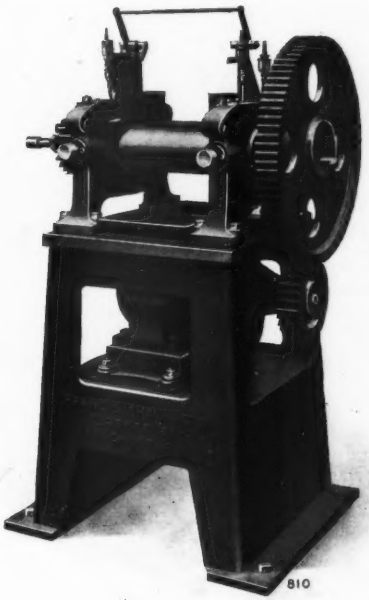
Telephone: Monarch 3871-2-3-4-5.
Telegrams: "Sternoline, Phone, London."

All enquiries should be addressed to:
Industrial Specialities Dept. 67

Also at Bradford & Glasgow.

SALES AND SERVICE
PLASTICS T. H. & J. DANIELS LTD. AH EQUIPMENT FRANCIS SHAW & CO. LTD.

SHAW
EXPERIMENTAL MIXERS



FRANCIS SHAW SINGLE-GEARED LABORATORY MIXING MILL, with 13" x 6" rolls having steam and water centres, water-cooled bearings, screw adjustment front roller, guide plates to each end of nip, sheet steel mill pan, guards and electrical equipment.

Further details on request.

THE BRITISH PLASTICS FEDERATION LIMITED

MAKERS:
FRANCIS SHAW & CO. LTD., MANCHESTER
SOLE AGENTS FOR GREAT BRITAIN, INDIA, FRANCE AND ITALY
ALFRED HERBERT LTD., COVENTRY

Moments *that* Matter . .

"Bombs gone O.K....."

DOWN go the bombs on that tiny speck of a target ... it's the moment for which these men have risked their lives. It's a moment, too, when mouldings play a vital part, contributing to the amazing accuracy of our bombers. Such moments justify the care taken in the design and manufacture of our products.

For

Mouldings *that* Matter . .

KENT MOULDINGS

PROPRIETORS, KOLSTER BRANDES LIMITED

FOOTSCRAY, KENT

Telephone: Footscray 3333

Telegrams: Kolsterphone Sidcup

BYSON

FOR BAKELITE

Acetate and other Synthetic Mouldings. Modern Plant and Facilities

APPLIANCE Co. LTD.

WOOLFOLD, BURY, LANCS.

Telephone: Bury 1560-1 Telegrams: "Bysonite, Bury."

Pioneers!

in MOULDS for MODERN PLASTICS

also Press Tools, Jigs and Gauges.

BARBER & DUFFY LTD

214/222, Cardigan Road, LEEDS,

Telephone: LEEDS 52033

Member of the Gauge and Toolmakers' Association.

BRITAIN'S LEADING HACK-SAW BLADE—

DING-DONG

PRACTICALLY UNBREAKABLE

also

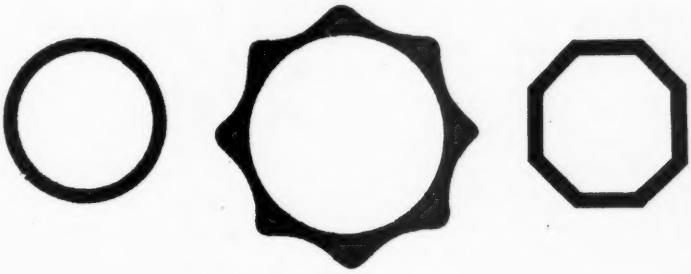
HIGH SPEED STEEL BLADES

Supplied by Tool Dealers, Engineers' Merchants, Mill Furnishers, etc.

Manufactured by :—

CHARLES BAYNES LTD.,

KNUZDEN BROOK, BLACKBURN.



"Rockite" Thermo-Setting Extruded Sections

Produced from Special Grades of the well-known "Rockite" Phenolic-type Moulding Materials

Uniform cross-sections in unlimited lengths. Range of colours as for Phenolic pressure mouldings.

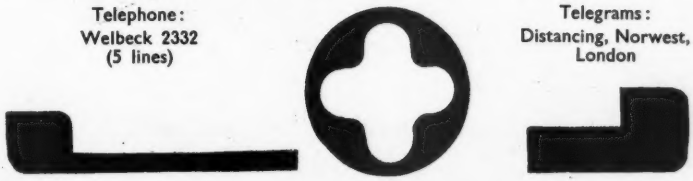
Excellent Chemical and Electrical properties.

Apply for Descriptive Leaflet to the Sole Distributors :—

F. A. HUGHES & CO. LIMITED

Telephone: Welbeck 2332 (5 lines)

Telegrams: Distancing, Norwest, London



B

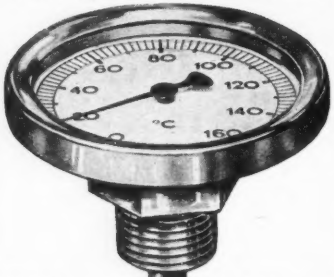
RM
SERVICE and DEPENDABILITY

Doing the job!

It is not always a question of metal substitution. Plastics correctly adapted may be the right material for the job. Save those machining operations. Have it moulded by :—

ROOTES
Mouldings Ltd
SLOUGH, BUCKS Telephone: Slough 22349

PLATEN THERMOMETER



Dial type thermometers for every industrial purpose.

Models for Plastic and Bakelite moulding processes.

Rototherm
DIAL THERMOMETERS

THE BRITISH ROTOTHERM CO., LTD.
Merton Abbey, London, S.W.19. Liberty 3406
Showrooms: 7c, Lower Belgrave Street, Victoria, S.W.1

STEEL-SHAW
PEBBLE MILLS

For the grinding of all kinds of Powders, Chemicals, Minerals, Colours, Paints, Enamels, etc. Supplied lined with hard Porcelain, Silex or special linings, and can be insulated to suit particular classes of work.

Send for our free illustrated literature.

STEELE & COWLISHAW, LTD.,
Engineers
(Dept. No. 27), COOPER STREET,
HANLEY, STOKE-ON-TRENT.
London Office: 339, High Holborn, W.C.1
Telephone: Holborn 6023.

Nearly ½ a Century's Experience in Grinding

HYDULIGNUM
HIGH DUTY WOOD

Makers of Synthetic
RESIN PAPERS
(Impregnated and Coated)
For the MANUFACTURE of LAMINATED SHEETS & TUBES
CAMBERWELL BEAUTY
Regd. Trade Mark
SAMUEL JONES & CO., LTD
16-17 NEW BRIDGE STREET, E.C.4. PHONE: CENtral 6500

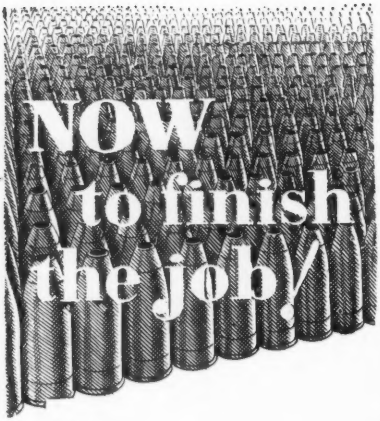
Hints on machining
TUFNOL
THE ENGINEERS MATERIAL, NON-METALLIC, LIGHTWEIGHT

Our "Manual on Machining Tufnol" gives full data on all machining processes.

FILING. The ordinary single or double cut engineers' file is quite suitable for filing Tufnol. When the edge of Tufnol has to be filed, chamfer the back edge and support it with wood or similar material to avoid chipping or slight delamination, and work diagonally. A wood tumbling barrel will remove rough edges and swarf. Light application on a dry mop will produce a polish. "Tufnol Finishing Oil" will give a specially fine finish.

TUFNOL LTD
PERRY BARR BIRMINGHAM 22B

From the simplest MOULDING
to the most complex job
PRESS
Moulded Products
CHESTER ROAD · TYBURN · BIRMINGHAM
LTD
DESIGN
MOULD MANUFACTURE
RESEARCH
MOULDING



Yes! We have the tools. But men are needed to use them. And it is evident in every 'comb-out' that industry must supply the men, too.

Yet industry will still be expected to keep output up at peak levels until the job is done.

That's not such a tall order as it sounds, for admitting prodigious figures of output the methods generally lacked the streamlining which makes all the difference between forcing out and flowing out.

Attention must now be given to these finer points, not only to win the war, but to brace ourselves for—afterwards.

Kardex has been solving many of these problems over the past five years, gathering experience, sorting data—and is now ready with practical solutions for this year's difficulties. If you have time, now, to think ahead, Kardex is ready to plan with you.

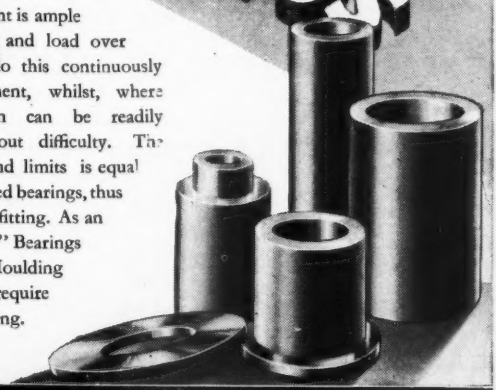
★ *PRODUCTION CONTROL, by A. R. Jackson. The above booklet presents an outline of production control problems and practical solutions. Sent on application for 1/- post free to Dept. P.10. Kardex systems are available only to essential industries.*

KARDEX
DIVISION of
KARDEX VISIBLE CONTROL SYSTEMS
1-19, NEW OXFORD STREET, LONDON, W.C.1
CHAncery 8888
"ADMINISTRATIVE MACHINE TOOLS"

Trustworthy Friends...
DURAWIRES
DURACABLES
For all applications where only the best is good enough
DURAWIRES & DURACABLES
are not a WAR substitute . . . They are not a substitute at all in the sense in which this irritating word is generally used. DURAWIRES AND DURACABLES have their own OUTSTANDING PROPERTIES and will play their part in building the New World as they have helped to win the war.
Oil Proof
Petrol Proof
Non Inflammable
Non Ageing
P.V.C.
DURATUBE & WIRE LTD
Fagge Road · Feltham · Middlesex
P.V.C.

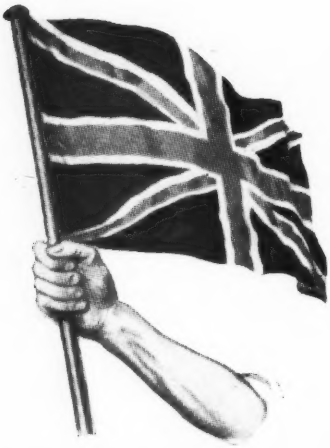
Bronze of cellular structure impregnated with lubricating oil

Oilite OIL-CUSHIONING BRONZE BEARINGS



"Oilite" reduces bearing failures to a minimum wherever it is applied to suitable components. The lubricant content is ample to cope with variations in speed and load over a considerable range, and will do this continuously during the life of the component, whilst, where necessary, additional lubrication can be readily embodied in the design without difficulty. The accuracy of finished dimensions and limits is equal to that of the highest grade machined bearings, thus making for ease of assembly and fitting. As an alternative to force fitting, "Oilite" Bearings can be incorporated in Plastic Moulding during Moulding, but will require impregnating with Oil after processing.

THE MANGANESE BRONZE & BRASS CO. LTD
HANDFORD WORKS, IPSWICH TELEPHONE IPSWICH 2127 TELEGRAMS "BRONZE IPSWICH"



VICTORY IN EUROPE

•••— •••— •••—

CRYSTALATE

CONTINUE TO OFFER THE SERVICE OF 46 YEARS EXPERIENCE IN THE ART AND PRACTICE OF PLASTIC MOULDING

TONBRIDGE, Kent. Phone: HADLOW 233/4/5 (20 lines)

Reduce "form filling" by making maximum use of the original written record.

A well planned form layout with the requisite number of carbon copies, written on a Paragon Autographic Register, will keep paperwork down to the minimum.

AND . . . the Paragon Register does all but the actual writing. It assembles forms and carbons, issues the written forms and copies, and files one or more copies for reference and checking.

See how Government Departments, Local Authorities, Commercial concerns and Industrial undertakings are using the Paragon Register to save writing time.

Send 1d. stamp for full particulars.

LAMSON PARAGON SUPPLY CO., LTD.

Dept. "M," PARAGON WORKS, LONDON, E.16

Telephone: ALB Dock 3232

TAS/LP47

Fuel efficiency starts with

YOU

Specialist ideas for Management

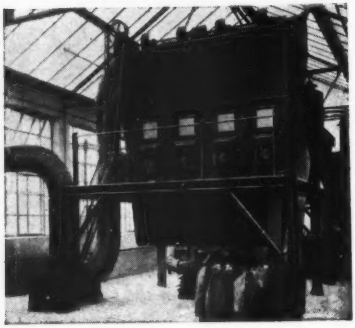
FUEL EFFICIENCY is not only a wartime expedient: it is a basic factor in factory control. There cannot be any doubt that plant output and production costs—vital elements in all future plans—depend to a very considerable degree on correct and efficient fuel usage. • To help industrial management the Ministry of Fuel and Power have issued a series of Bulletins, written by experts and full of really practical suggestions. They cover almost every aspect of the efficient use of fuel, heat and power.

The personal attention of management is directed especially to the following Bulletins:

NO. 7 'The Appointment and Responsibilities of Fuel Watchers.'
NO. 8 'Bonus Schemes for Fuel Economy in Industry.'
NO. 12 'Thermal Insulation of Buildings.'
NO. 13 'Fuel Economy by Saving Electricity.'
NO. 15 'The Effect of Variations in Output on Heat Consumption.'
NO. 21 'The Construction of a Factory Heat Balance.'
NO. 26 'Peak Steam Demands. Cause, Effect and Cure.'
NO. 31 'Fuel Economy by Water Saving.'
NO. 37 'Small Vertical Boilers, Steam Cranes and Shunting Engines.'

● **MAY WE SUGGEST that you call together for a few minutes your departmental heads and fuel watchers. Ask each to check the Bulletins he already holds and those he ought to have. Extra copies will be supplied free by your Regional Office of the Ministry of Fuel and Power.**

ISSUED BY THE MINISTRY OF FUEL AND POWER



Dust Collection

In the manufacture of plastics, such as gramophone records and moulded components, Visco Dust Collectors are proving invaluable.

At left is shown a "Visco-Beth" Automatic Equipment dealing with powdered gum. The dust collected from the grinding mills is automatically discharged into bags, the cleaned air being vented, *via* the discharge bend on the left, to atmosphere.

For the collection of the fine dust produced in grinding and polishing, Visco Unit Dust Collectors of the "Static Bag" type will be found highly satisfactory.

VISCO
ENGINEERING Co. LTD
STAFFORD ROAD. CROYDON.

Telephones: CROydon 4181-4 & 2471
Telegrams: "Curtmit, Croydon."

Also Makers of Air Filters & Water Cooling Plants.

KING *Electric* CHAIN PULLEY BLOCK

The King Electric Chain Pulley Blocks are built for continuous heavy duty. Three models are available: Minor, Major and Mammoth, ranging in capacity from 5 cwts. to 10 tons. Write for illustrated booklet on Lifting and Shifting.

GEO. W. KING LTD HITCHIN · HERTS

MANCHESTER CENTRAL 3947 | NEWCASTLE 24196 | GLASGOW DOUGLAS 2798-9

COURTAULDS
LIMITED

CELLULOSE ACETATE MOULDING POWDERS SHEETING, FILM AND TUBING

Regd. Trade Mark

Fileshill Road, Coventry Tele: Coventry 88771

FERGUSON'S • NESTORITE • MOULDING POWDERS

Answer:

FERGUSONS—
or I am a Scotsman!

JAMES FERGUSON & SONS LTD

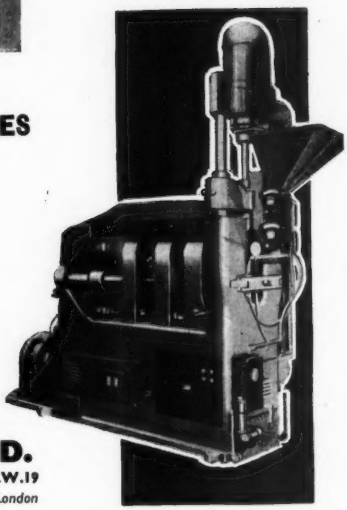
MERTON ABBEY LONDON S.W 19

Dominion and Foreign Representatives: A. S. HARRISON & CO. PTY. LTD. 85 Clarence Street, Sydney, Australia. JOSE DELCLOS, Gignss, 39 Barcelona, Spain

Phone: Mitcham 2283-5

LESTER

FULLY AUTOMATIC INJECTION MOULDING MACHINES



OUTSTANDING FEATURES

Frame construction provides unsurpassed rigidity.

Vertical arrangement of injection pump saves floor space and makes rear mould easily accessible.

Central mould adjustment by crank handle, worm and worm-wheel drive supporting the mould plate in its centre, thus preventing flash.

Pressure reducing and flow control valves provide extreme versatility for handling most varied materials.

Toggle levers with steel cam faces take the entire force of the injection. Cam faces lubricated automatically.

No loose connections or tie bars requiring to be tightened.

Standard capacities 2 oz. to 22 oz. per shot.

Sole British Representatives

DOWDING & DOLL LTD.

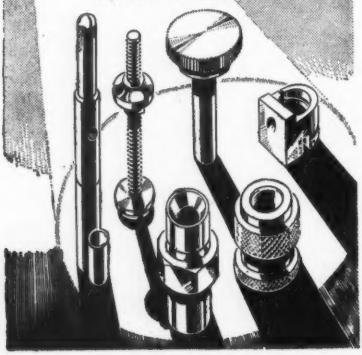
3 THE GREEN, WIMBLEDON COMMON, LONDON, S.W.19

Telephone: Wimbledon 5395/7 Telegrams: Accuratool, Wimble, London

---

DAVIS & TIMMINS LTD

New light on the problem of small turned parts and inserts



Head Office: BILLET ROAD · WALTHAMSTOW LONDON · E.17

Phone: Larkswood 2244 and 4461 GA

COATING COMPOUNDS

-for fabrics and paper

of

POLYVINYL CHLORIDE
POLYVINYL FORMAL
POLYVINYL BUTYRAL
ETHYL CELLULOSE
NITRO-CELLULOSE
METHYL METHACRYLATE

Full details from

VINYL PRODUCTS LTD.

BUTTER HILL, CARSHALTON, SURREY

WALLINGTON 5333/4

London Office:

80 Bishopsgate, E.C.2 London Wall 5310

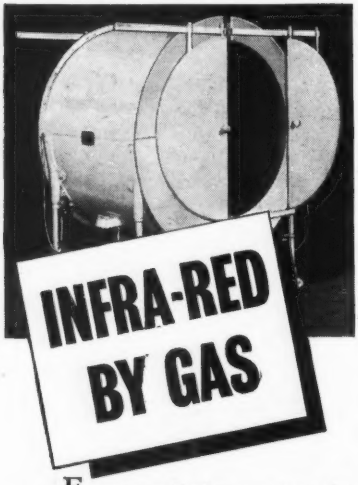
V.P. VINYL PRODUCTS LTD

ADHESIVES · EMULSIONS · LACQUERS · SHEETS

GOOD LIGHTING IS A TONIC
ESPECIALLY WITH OSRAM
A new era of brightness in the home, office and factory! Brightness, cheerfulness, cleanliness, fresh air, good health and good lighting are the order of the day. Good lighting is a tonic –especially with Osram!
Osram
THE WONDERFUL LAMP
A G.E.C. PRODUCT

Advt. of The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2

The gas-fired infra-red tunnel below is one small example of many types built for special purposes.



INFRA-RED BY GAS

For war production purposes paint curing by convection ovens has often proved a serious bottle-neck. To-day, by using gas-fired infra-red apparatus, giving a high output over large areas, protective finishes can be baked in minutes instead of hours.

Basic advantages are:

1. Simple, robust, inexpensive, compact equipment, giving long life with minimum maintenance.
2. Operating units easily constructed in different sizes and shapes, without the need for complicated auxiliary apparatus.
3. Very wide range of flux density, which can be reduced merely by turning down the gas.
4. Even distribution of radiation.
5. No material difference in drying time due to colour.
6. Low capital and fuel costs.

Any curing, drying or baking process which can be carried out in a short time at a high temperature, instead of a long time at a low temperature, is specially suited to the infra-red process, and in some cases this can be applied to existing conveyor ovens.

SEND FOR A COPY OF THIS PAPER

Further information is contained in a Paper entitled "Infra-Red Drying" by F. L. Atkin, M.I.Mech. E., M.Inst. Gas E.

BRITISH GAS COUNCIL,
1 GROSVENOR PLACE, LONDON, S.W.1

BOXFOLDIA CONTINUES TO GIVE VALUE!

FURTHER PRICE REDUCTION

As from 4th June our prices will be further reduced by 5% for all orders already on our books but not delivered, and for all future orders. We base our prices on our pre-war profit standard

BOXFOLDIA LTD
BOURNBROOK BIRMINGHAM

'Phone: SELLY OAK 1164 P.B.X.
'Grams: "Boxfoldia, Birmingham"

WANTED—STOCKS for CASH

WE are cash buyers of merchandise of every description. Clearance Stocks, Discontinued Lines, Surplus Stocks, in fact, goods of all kinds can be disposed of through us, without delay, on the most favourable terms, and without trouble.

SHOULD you have anything for disposal, either now or at any future time, please send us samples, full particulars and price on a cash settlement basis.

RELIANCE TRADING COMPANY,
13, New College Parade,
Finchley Road,
LONDON - N.W.3

TRIPLE U BRAND
PATENT No. 322957
PATENT LEATHER
PACKINGS
Specially Designed
FOR PLASTIC PRESSES
JOHN TALENT & CO. LTD
ASHWORTH STREET WORKS, MANCHESTER 8

LEAD

. . . and ANTIMONY

WHITE LEAD
RED LEAD
ORANGE LEAD
LITHARGE
SULPHIDES OF ANTIMONY
WHITE METALS

Supplies of the above products are available for essential (defined) purposes — subject to release by the Control.

Also other Low Melting Point Alloys in Ingots, Castings and Extrusions.

ASSOCIATED LEAD MANUFACTURERS LTD
embracing
Locke, Lancaster and W. W. & R. Johnson & Sons Ltd × Walkers, Parker & Co. Ltd.
The Cookson Lead and Antimony Co., Ltd × Foster, Blackett & James Ltd.
The Librex Lead Co., Ltd.
LIMPSFIELD COURT, OXTED, SURREY × CRESCENT HOUSE, NEWCASTLE-ON-TYNE × LEAD WORKS, CHESTER

ALM

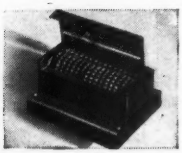
. . . . no need to worry, consult us, and if injection mouldings can do it. we offer our Services.

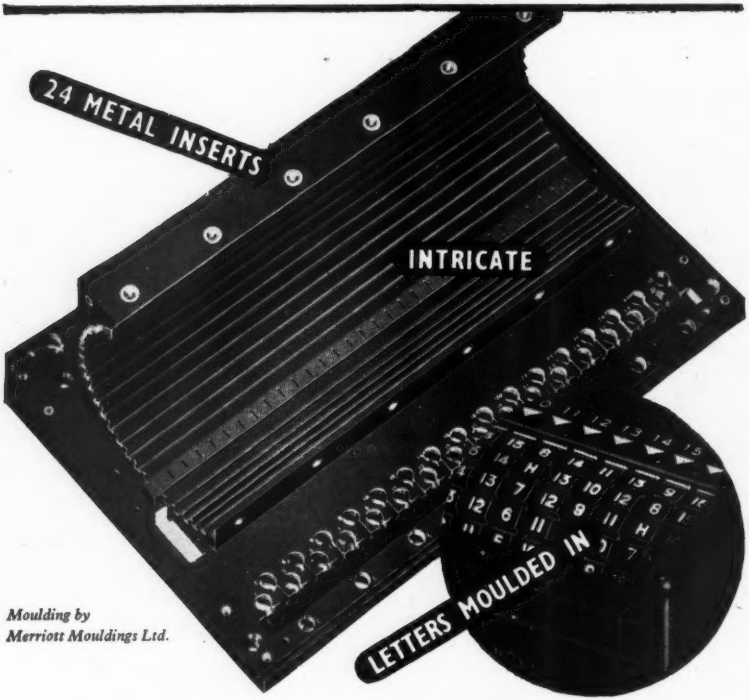
PUNFIELD & BARSTOW
(MOULDINGS) LTD

BASIL WORKS, WESTMORELAND ROAD, QUEENSBURY, LONDON, N.W.9.
'Phone: COLindale 7160 & 7956. 'Grams: Punfibars, Hyde, London.

FOR INJECTION MOULDINGS

Study this bomb-load pre-selector





Moulding by
Merriott Mouldings Ltd.

EXCEPT for the metal cover it is moulded entirely from Bakelite Moulding material X20/5HD. No fewer than 24 metal inserts are successfully incorporated in the base and the letters and numbers in the contact discs are moulded in and not engraved. Apart from the immense saving in production time thus effected, its great advantage over previous types is that **IT SAVES OVER 2¼ LB. IN WEIGHT**

TREFOIL

BAKELITE PLASTICS

REGD. TRADE MARKS

Pioneers in the Plastics World

T32

BAKELITE LIMITED · 18 GROSVENOR GARDENS · LONDON S.W.1

Vol. IX. No. 98 JULY, 1945

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - - M. D. CURWEN, B.Sc., A.R.I.C.
Offices - Bowling Green Lane, London, E.C.1

CONTENTS

	Page
Editorials	316
Whither Polystyrene? ..	319
Plastic Applied Coatings, by E. E. Halls	321
World's Industry Employs Plastics	332
Vibratory Grinding of Macromolecular Substances	335
Microscopic Examination of Plastic Materials, by J. H. Wredden, F.R.M.S.	341
Production News	347
Planned Mould Maintenance (Part XIV), by W. M. Halliday	349

NOTICES

"PLASTICS" is published in London, England, on the second Wednesday of the month.

All instructions, matter and passed proofs for all kinds of advertisements must reach the Head Office of "PLASTICS" by the 24th of each month to ensure insertion in the following month's issue.

Head Offices:
Bowling Green Lane, London, E.C.1.
Inland Telegrams - - "Pressimus, Phone, London."
Cables - - - - - "Pressimus, London."
Telephone - - Terminus 3636 *(Private Exchange).*

Midland Offices *(temporary)*: 241, Warwick Road, Kenilworth, Coventry.
Telephone } *Kenilworth* 415
Telegrams }

Northern Offices—Manchester: Deansgate House, 274, Deansgate.
Telephone—Blackfriars 5038-9.
Telegrams—"Presswork, Manchester."

SAVE PAPER

More than ever is paper waste required for our war industries. Waste paper makes munitions in a hundred forms—from shell cases to aeroplane parts.

The fact that goods made of raw materials in short supply because of war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

EDITORIALS

Plastics in France 1940-1945

IT was with pleasure and with considerable grace that Mr. G. C. S. Cooper, as chairman, introduced Professor de Nivelle, of Mulhouse University, at a meeting of the Institute of Plastics on May 20. This pleasure was equally shared by his audience, who were anxious to hear what had happened within France during the war years.

His story was one that, in broad outline, we had presumed would be the case of a country overrun by Germany—lack of raw materials, of coal and of electricity, lack of metals for replacements, and, finally, with two million young men prisoners of war, lack of labour. On the other hand, the creation of replacement materials was indispensable.

It is not surprising, therefore, that the production of vinyl products, almost unknown in France in 1939, and produced primarily as substitutes for vanished rubber, grew to a high level. This, presumably, was enormously helped by the carbide and acetylene plants, which have long been a stand-by in France, especially in Haute Savoie. The Saint Gobain company, which we suppose is the famous glass-manufacturing concern, is now making 100 tons of polyvinyl chloride per month. The Rhône-Poulenc company, best known here for its high-quality cellulose acetate, set up the manufacture of polyvinyl chloride (50 tons per month) from dichloroethane and polymerized in emulsion form, and of polyvinyl acetate (120 tons per month), as a powder and in solution and emulsion forms. These high production figures are exclusive of some quantities of the co-polymers of the chloride and the acetate, of polyvinyl alcohol and of acetals produced by Resines et Vernis Artificiels, Rhône-Poulenc and Société Nobel.

Professor de Nivelle, in talking of the production of finished goods from these materials, told of the use of anthracene oils as plasticizers when butyl-phthalate and tricresylphosphate disappeared from the market. No doubt those fractions boiling over 280 degrees C. are good plasticizers, but we always understood that such fractions contained carcinogenic compounds and were suspect.

Other noteworthy points regarding production were:—Reconstituted leathers made from leather fibres and polyvinyl compounds; textile fabric from pure polyvinyl chloride; the production of sulphur plastics, probably akin to Thiokol, by several firms; the manufacture of water-meters (turbine, filter, clockwork) of polystyrene with a one-hundredth millimetre accuracy; the production of nylon which was maintained at a low level to mislead the Germans. It was interesting to hear that not only were filter-cloths and stockings made, but also that nylon has been examined for the adhesion of metals and for injection moulding.

The lecturer did not refer in great detail to the phenolics and amino resins, since the former relied on stocks, which were almost exhausted by 1942. What was available was employed for the production of laminated forms and for high-priority work, such as grinding wheel production. The urea resins followed a similar course, and the quantities available were mainly used for glue production.

During his talk Professor de Nivelle mentioned that three-quarters of the bearings used in Germany were made of plastics. This remarkably high figure was questioned, as well it might.

In all, it was a most enjoyable paper, and, because of the professor's modesty, it was left to some of his audience to describe some of the dangers French workers underwent to mislead the Germans as to actual production and, what is perhaps equally important, special researches that were undertaken under the very noses of the Gestapo.

The Microscope

THERE is probably no industry which has not benefited materially when the microscope has been called in as an analytical or control weapon.

The plastics industry has not yet adopted this instrument. Very little microscopic examination has been carried out by its workers or, at least, no information regarding results obtained have reached the scientific and technical journals. It would be difficult to lay down the lines for proceeding on what in other scientific and technical fields would be called a systematic study, since examination of pure resins by the optical microscope would not, we presume, be very fruitful. It is rather in the technical utilization of resin in conjunction with fillers, and its incorporation with laminations of wood, paper and fabric, that the microscope should yield much of use.

Because we are convinced of this, we have asked Mr. J. H. Wredden, Chief Chemist of the Igranic Electric Company, who has a considerable experience of plastics and is a microscopist of a very high order, to contribute to this journal some of his practical experiences in this field. They are, as will be appreciated, limited in scope, even though they cover in themselves wide ground enough. But it is not difficult to see how, with proper employment and understanding, the microscope can tell us much with regard to the behaviour of resin-filler mixtures and may yet provide us with the means of greater control over flow in the mould.

Good Relations

WE have already referred in these pages to the happy relationship between the plastics industry, the British Plastics Federation and Plastics Control.

It is good to read that this has been confirmed by official circles, for we cull the following from the Eighth Report of the Select Committee on National Expenditure.

"As regards the remainder of the report, the Ministry of Supply is glad to note that the Committee absolve the Controllers and their staffs from imputations of bias by reason of their previous business connections (paragraph 8), and reach the conclusion that the inquiry has not brought to light much that calls for specific criticism of the activities of the Controls (paragraph 23). Certain passages, however, could be interpreted as qualifying that conclusion and appear to have been regarded in some quarters as endorsing allegations or complaints submitted to the Committee by 'certain trade associations and firms' which are referred to in paragraph 1 of the Report. Lest the reference to trade associations should be misunderstood, the Association of British Chemical Manufacturers, which represents in its membership practically the whole of the British chemical industry, has pointed out that it submitted no memoranda, nor were its representatives heard, arrangements made for the hearing having been cancelled at the instance of the Committee; the Association adds that no case of unfair discrimination in the operation of the Controls has been reported to it. The British Plastics Federation also has drawn attention to the fact that it was not invited to submit a memorandum or to give evidence and that happy and satisfactory relations have existed between the industry and the Plastics Controller."

Tropic Proofing

SOME three years ago a report from Australia on conditions in the New Guinea campaign included some information regarding the growth of moulds on plastics, in some instances on phenol-formaldehyde mouldings which formed part of instruments. This caused at the time considerable surprise.

The Ministry of Supply has now published a Report on Tropic Proofing which covers the methods adopted for proofing textiles, cordage, wood and paper, etc., employed in the Far-Eastern campaigns. Included is a short section on Plastics, and although the information collected on the behaviour of these materials is by no

means complete, the results of tests so far carried out are valuable. The following is a summary of these findings, which have been compiled by the Advisory Service on Plastics and Rubber.

Both phenol-formaldehyde and urea-formaldehyde resins appear to resist attack by fungi to a marked degree. Growth is usually confined to cut edges and is not likely to have a serious effect. Laminated phenolics with cellulosic fillers are more readily attacked. Very little growth is noted on moulded specimens filled with mica or asbestos.

Thermoplastics are liable to soften and distort under similar conditions. Cellulose acetates vary in behaviour as regards fungal growth, some formulations proving resistant while others have not. Polystyrene and polymethyl methacrylate can be used with fair degree of safety except for optical instruments, while both polythene and nylon are generally suitable for tropical use. P.V.C. possess a high degree of resistance.

As already pointed out, the work is far from complete, and tests are to be continued under actual tropical conditions. We hope that these will also include examination of resistance to attacks by white ants (termites).

BOWEN PRIZE FUND

The Council of the British Plastics Federation, as administrators of the Bowen (Cables and Plastics) Prize Fund, offer three prizes, to the value of £50 each, for award in June, 1946.

The prizes will be awarded for original scientific contributions in chemistry, physics, engineering or chemical engineering of post-graduate standard and having a bearing on the plastics industry.

Two of the prizes will be open for competition only for employees, of not less than 12 months' service, of member firms of the British Plastics Federation

One prize will be open to anyone domiciled in Great Britain.

The council reserves to itself the right to restrict the number of prizes awarded if contributions should not be deemed to be of sufficiently high standard.

Contributions, which *must not bear* the name of the author, should be enclosed in a sealed envelope and forwarded with a covering letter giving the following:—

Name and address of author.

Name of his employers and length of time he has been employed by them, with a letter from a responsible official representing his employers giving permission for the author to submit the contribution.

Authors of contributions for the open prize, if not employed by an industrial undertaking, should state their occupation. If authors of contributions for the open prize are employed by member firms of the Federation they should submit also a letter from their employers giving them permission to submit the contribution.

Contributions should be sent to the General Manager, British Plastics Federation, 47-48, Piccadilly, London, W.1, so as to reach him not later than first post on Saturday, March 30, 1946.

It is the desire of the council of the Federation that all suitable contributions submitted for these prizes shall be published, but it reserves the right to determine, in conjunction with competitors, the method and place of publication.

REFERENCE FILE ON PATENTS

Those excellent American publishers, Interscience Publishers Incorporated, of 215, Fourth Avenue, New York, have issued a remarkable Patent Digest Service (resins, rubbers, plastics) in the form of a loose leaf service. It is edited by Dr. H. Mark.

The subject matter covered consists of new developments in the manufacture and applications of resins, rubbers and plastics. The policy is to cover all the American patent literature and, selectively, the foreign literature, on the manufacture of resins, rubbers and plastics, as well as to cover fairly completely the industrial applications of these materials. The main intent is elimination from the letters patent of all items, phrases and reiterations introduced for legal purposes only, and to reconstruct only the novel and essential art in a clear form.

The first issue contains the table of contents. It shows that the arrangement has been made mainly according to the chemical composition of the substances under consideration. Chapters on natural resins and derivatives are followed by chapters on varnish-type resins, alkyd resins, chlorinated resins, synthetic rubbers, vinyl derivatives. Price per year, $45. Binder, $3.50.

Whither Polystyrene?

A Letter to the Editor

Sir,—A short while ago I saw an editorial in the December, 1944, issue of your excellent publication under the title "Polystyrene," and in the context noted reference to a lecture given in February, 1941, on the subject of the polymerization of styrene. Having given such a lecture, I was encouraged to look further into the matter, and have now obtained the editorial of March, 1941, in which you give an account of the lecture. You are probably wondering why you have had no reply to either editorial, and so a few words of explanation are perhaps in order. As you will see from the address, I am now in the United States, having been sent here from England on a mission shortly after giving the lecture on styrene at Burlington House.

I should like to discuss briefly the points raised in your editorial concerning the price of polystyrene and its production rate:

In February, 1941, I was chiefly concerned with the technical aspects of styrene and had been associated with its development for use in electrical systems for a number of years. I had seen the price drop considerably, but it was still a relatively expensive material, the import of monomeric styrene from Germany having ceased, imports from the United States very small and uncertain, and the home market, Boake Roberts and the Distillers Co., just in their infancy. I should perhaps have refrained, as you suggested, from commenting on price considerations when asked by Mr. Austin Lowe, but in the electrical industry at that time there was no other suitable material, and therefore price was a secondary factor. Other volume uses for styrene had not at that time been developed, and so no basis existed for the home market to produce in the quantities necessary to insure low cost. I maintained at that time, and have always maintained, that styrene and polystyrene are among the potentially most useful of plastic materials, and everything I have seen and heard since strengthens my conviction.

I have been very fortunate during my sojourn here in the States to be associated very closely with the plastics industry, and, in particular, with the styrene picture, and I should like to give you my thoughts on the subject of "Whither polystyrene?"

In the United States, as in Germany, monomeric styrene production was relatively small until the demand of synthetic rubber arose, and, as a consequence, the polystyrene available was low in quantity and high in cost. Cellulose acetate, available in quantity and relatively cheap, was the preferred thermoplastic for low-cost injection mouldings for toys, trinkets, etc. The huge plants constructed in connection with the synthetic-rubber programme have now made the manufacture of monomeric styrene one of the largest synthetic organic chemical processes known, and the production figures, although still secret, are staggering. Current expert opinion is that the price of monomeric styrene will drop to 9 cents per lb., although some optimists have gone as low as 7½ cents per lb. It seems to me that whether this figure can be reached depends on two factors: (1) Will the war in the Far East deprive us of natural rubber long enough for the GR-S rubber to be improved in quality and usefulness and produced at a price cheaper than the natural product, thus making it advisable to continue its large-scale manufacture in peace; and (2) can sufficient demand be found for the product to be produced in the quantities necessary to secure this low price? These factors are not fully resolved as yet. With monomeric styrene at 9 cents per lb., say, then polystyrene at 12 cents

to 14 cents per lb. is considered feasible, thus making this the cheapest of the thermoplastics, and, for that matter, the cheapest of all plastics.

A glance at the price trends for the past three years is informative:—

		Cents per lb.
December, 1942 ...	Clear	32
	Colours	39
December, 1943 ...	Clear	32
	Colours	39
July, 1944 ...	Clear	32
	Colours	39
December, 1944 ...	Clear	29
	Colours	36
February, 1945 ...	Clear	27

The present price of polystyrene, together with its outstanding electrical and good mechanical properties, makes it the most attractive of thermoplastic materials, and there are already indications that cellulose acetate will give place to it when supply is available in the majority of general-purpose mouldings.

Perhaps the most important aspect, which, to my knowledge, has not been sufficiently discussed and stressed, is the use of this cheap raw material as a basis for improved plastics, plasticizers, and intermediates. There are indications that even more useful products will be forthcoming, and already in semi-plant scale we have such items as polydichlorostyrene, Styraloy 22, cross-linked polystyrene, hydrogenated polystyrene, hydrogenated distyrene, styrene dibromide, etc., all possessing valuable properties and suitable for specific uses.

Your figures on styrene production are somewhat low for the States. By the summer of 1943, four major companies here were committed to supply a total of 183,700 tons of monomeric styrene, and this figure has increased since.

For plastic-moulding materials the following figures given by the War Production Board for 1944 are interesting:—

	lb.
Urea and melamine moulding compounds	36,000,000
Phenolic moulding powders	120,000,000
Polystyrene	9,000,000
Acrylics	35,000,000
Polyethylene	9,000,000
Vinyl resins	120,000,000
Cellulose ester plastics	83,000,000
Ethyl cellulose ...	12,000,000

Owing to the current shortage of polystyrene, due to the demands for styrene in the GR-S programme, many applications for this material are denied.

You will thus see that your figure of 1,000 tons of polystyrene really should be 4,500 tons, a not inconsiderable volume of what was once almost a curiosity.

Should the British industry figure for polystyrene be only 300 tons, I would say that need exists to review the situation at once to avoid being forced into a subordinate position vis-à-vis the American industry.

In conclusion, I would ask the same question as you: "What will happen to our own production?"—Yours sincerely,

ARTHUR J. WARNER.

South Orange, New Jersey.

SILICONE RESINS

Mr. William Penn's article in your June issue was extremely interesting, but I feel a word must be added to qualify the author's statement that "the efficiency (of electric motors) has almost unbelievably been increased" by the use of silicone varnishes.

By increasing the working temperature of an electric machine, much greater outputs can be obtained, or conversely the machine may be made much smaller and lighter for a given output. This increase in working temperature does not, however, result in increasing efficiency in operation and may even lower the overall efficiency due to increased losses.

I believe Mr. Penn intended to imply that the efficiency of production is improved due to the possibility of making smaller machines to do the same work, but this must not be confused with the electrical efficiency.

H. R. HEAP.

Chelmsford.

Plastic-applied "Coatings" by Spray and Dip (Contd.)

In this Section of his Paper the Author Deals with the Production of "Flock" Surfaces and the Use of Solventless Varnishes

By E. E. HALLS

IN the previous section of this article, which was presented in the January, 1945, issue of "Plastics," the application of coatings to articles that might consist of components, sub-assemblies, assemblies, completed equipments, or even raw material in the form of sheet stock, etc., was dealt with on the basis of the coating medium consisting of pure plastic, or of plastic compounded with plasticizer and/or filler and pigment. The feature stressed was the avoidance of a solvent carrier. The methods of application discussed included the immersion of the work to be coated in a vat containing the plastic in a molten condition, that is dip treatment, and the use of solid plastic in powdered form applied by means of a flame gun of the Schori type. This latter process in particular has very many possibilities, and, extensive as has been the development and industrial applicational work to date by the Schori Co., hot plastic spray must still be regarded as being in its infancy. Consequently, much will be expected from this type of process in the future.

The process that is usually designated "flock" spray, and which uses chopped textile flock as its raw material, may also be deemed to come under the heading of this article. Up to a point, this is true, because the flock employed may comprise a synthetic fibre, such as, for example, regenerated cellulose or cellulose acetate. Again, the future will no doubt see this process utilizing some of the newer synthetic plastic fibres, such as nylon and polyvinylidene chloride among others. Therefore, a brief discussion of the technique of flock spraying and reference to its applications will be included here. However, it is emphasized at the outset that there is no resemblance or comparison between plastic powder spray by the flame gun process and flock spraying, and that the two processes answer different purposes and cover two distinctly different fields. Further, although the flock is applied as a dry powder, it does need an orthodox type of varnish or lacquer medium having a solvent carrier as a primary coat to provide its adhesive base.

The flock-spraying process, as its name rather suggests, imparts a coating of a flock-like nature, so that the layer of finish is felt or baize-like in appearance. A wide range of roughness, or of fineness or coarseness is possible, and, likewise, the heaviness of the layer may vary from quite thin to comparatively thick. The finish may be applied to almost any type of material surface, the only real stipulations being, as always in any kind of finishing operation, that the surface must be clean to receive the finish, and that adhesion must be assured in the usual manner either by preparatory surface treatment or by ensuring the correct quality of medium for the primary coating, or by a combination of these two factors. In this way, the finish may be applied to all types of metal work, to wood, paper or cardboard, to leather and textile fabrics, to glass and stone, slate and concrete, and to plastic-base materials.

The raw material, flock, used to date comprises cotton and wool, and the plastics cellulose acetate and regenerated cellulose, these last two items usually under the description of "art silk" or "rayon." The latter is very suitable for

the purpose and is employed extensively. The finish can vary somewhat in texture and in appearance in accordance with the compositional nature of the flock selected. Thus cotton flock can be chosen to give a suede-like finish upon clothing such as jackets and shoes, wool flock to provide a baize-like finish to table tops, the inside surfaces of drawers, cabinets, trays, the undersides of ornaments, etc., and art silk where a finish having a finer and more velvet-like appearance is desired, as for jewel and spectacle cases and the outside surfaces of fancy boxes. The quality of these flocks is given special attention in their manufacture so that the raw material from which they are produced is properly blended, and the product is of uniform fibre length and free from any foreign matter, while, further, assurance can be given that the rather bulky fibrous powder does not tend to clog, as might be expected from its nature, so that it is free from any troubles that might arise from this disadvantage during spray application. Naturally, it is necessary to keep the flock thoroughly clean and dry, because dampness may result in clogging and, therefore, erraticness or other troubles in spraying, apart from tending to cause a loss of richness of the natural velvety or suede-like finish, while extraneous dirt is bound to produce blemishes in the coating and thus some deterioration in the quality of the layer. Due precautions must be taken accordingly in packaging for transit and storage, as well as to arrange for dry stocking facilities.

The colour range in which these flocks are available is an extraordinarily wide one. It includes all the colours and a numerous variety of shades in each. Again, when required to yield some specific effect, a variegated or mottled pattern can be obtained, either by mixing the two or more colours together roughly in the bulk flock, or by separate application to the same job from separate spray guns.

Briefly, the process of flock spraying entails three essential operations. These are the preliminary cleaning, the application of the adhesive, and the application of the flock. A few brief details will be given on each of these items below.

Regarding the cleaning, all the usual processes commonly employed in metal and wood finishing shops are applicable. Metal work can be cleaned by means of solvent to remove oil and grease, automatically or by hand, using trichlorethylene, solvent naphtha, white spirit, etc., according to which is the more appropriate or readily available. This cleaning to remove all traces of all oils and greases must, of course, be thorough. Aqueous alkaline detergents may be employed if more convenient, and, in fact, must be employed if the contamination includes soap base grease of soluble cutting oil. Any metal corrosion products, rust and scale on iron and steel, verdigris on coppers and brasses or other high copper-containing alloys, and any white corrosion products on the aluminium, magnesium or zinc alloys must be removed with suitable acid treatments. When these chemical treatments are resorted to, care must be exercised to ensure that all traces of the chemicals used are completely removed by thoroughly washing in water, and the work, of course, must be perfectly dry before the application of the adhesive coating. In addition to this simple cleaning, one of the usual chemical pretreatments may be applied and the durability of the overall finish enhanced accordingly. These refer to phosphating (for example, bonderising) for iron and steel, M.B.V., chromic/sulphuric acid treatment or proprietary process for the aluminium alloys, a chromate treatment for the magnesium alloys and a phosphate or chromate treatment for the zinc-base materials. Alternative adhesion to bright or smooth metal surfaces may be improved and rendered more lasting by abrasive blasting with sand or crushed steel shot.

Woodwork should be clean, free from loose dust, and it can advantageously be filled and treated with a standard cellulose sealer. Glass, stone, card, leather, fabric, etc., must be clean, either by virtue of ensurance that they have not been

allowed to become contaminated, or by appropriate cleaning in accordance with the nature of the contamination and of the base material.

The adhesive is closely similar to a normal varnish or lacquer medium. It may be a cellulose-base material, or an air-drying synthetic such as an oil-modified glyptal, or, again, it may be a rubber latex product. The drying times of these materials are designed to suit the flock spraying process, so that after a short air-drying time of from 5 to 15 minutes, the

Fig. 9.—Flock spray gun (Aerospray Manufacturing Co., Ltd.).

solvents will have flashed off sufficiently to allow the flock to be sprayed and adhere. The adhesive medium is usually applied by spray, using a normal spray gun and conditions, with an air pressure of the order of 40 to 45 lb. for the cellulose and the synthetic media, and 20 to 25 lb. for the rubber latex primer. Special types of work may dictate other operating conditions, so the foregoing should be regarded as average. Again, there is no reason why the medium should not be brushed when circumstances render this procedure desirable or necessary —for example, in the absence of spraying equipment. Further, instances arise in which it is more appropriate or economic to use dip methods, and to cater for such circumstances the medium can be suitably adjusted to give the optimum draining and drying times.

The flock operation uses a specially designed spray gun. When it is applied, it only adheres to the tacky surface of the medium, so that, after a drying period of about one hour, any excess flock that is loosely adherent to the work surface can very easily be brushed off. It can be reused. Likewise the excess that collects in the spray booth and in the baffles or filters of the exhaust system can be collected for reuse. For this reason, it should be noted that a spray booth should be reserved for the flock spray only. The same one should not be employed for the application of the adhesive medium, otherwise it becomes gummed up, the flock adheres to this and cannot be recovered. This represents an expense loss as well as giving additional trouble in the cleaning of the plant.

When a single coating of flock is insufficient for a particular purpose, additional coats may be applied. The procedure is to permit the first coat to dry for about an hour, then to apply a coat of the adhesive medium, followed by a coating of the flock itself. This procedure may be repeated until the desired thickness has been built up to suit the specific service requirements.

The finish is a protection against corrosion, the adhesive coating ensuring this in the first instance, the flock layer adding its own contribution. The flock in itself is water and moisture absorbent, this being self-evident from its nature. Further, the finished surface is not a smooth one, although it is quite uniform; hence, it will tend to collect dust and loose dirt, but this, in the main, can be brushed off clean. These are, however, shortcomings that are known from the outset, and, as already indicated, the finish has its own spheres of usefulness to

serve without encroaching upon fields that it does not completely satisfy.

The flock spray gun, although special in design for the purpose, is not so vitally different from the normal pistol used in paint and enamel spraying. It may be fed with flock from a cup attachment on the gun, or from a suitably located pressure container. In both cases the flock to be sprayed is picked up by an air stream and injected into the main atomizing or directing stream of compressed air at the nozzle of the gun, this being in contrast with the gravity feed of liquid paint from a gravity paint gun, or the pressure feed of liquid paint from a pressure-fed system. The guns are quite inexpensive, and are supplied by the usual paint gun supply houses. Fig. 9 is taken from the catalogue of Aerospray Manufacturing Co., Ltd., and it illustrates their special purpose flock spray gun. The mechanism in general is of similar design and characteristics to their normal spray guns with duralumin body and feather trigger action. A relatively large flock container is carried beneath the gun. It is easily detachable for quick filling. Compressed air is by-passed from the main line through the flock in this container and it thus carries flock up into the gun behind the nozzle, whence it enters the main air stream at the nozzle and is carried forward on to the job. The Aerospray type F. F. booth, taken from the same source, is shown in Fig. 10. This is specially designed for flock spray and is patented. The gauze screen traps practically all the flock from the exhaust, and then the air is drawn through a specially constructed filter which is arranged in concertina form and thus has a very large area. This, it is stated, collects all dust, and therefore the exhaust air after passing through it may pass straight back into the shop atmosphere. This means much to maintaining the balance of intake and exhaust air in the shop, as well as conserving the domestic heating supply in the winter by not continuously exhausting warmed air from the shop. The fine dust adhering to the filter cloth can be shaken free into a collector by means of a lever provided. In the photograph in Fig. 10, one side of the filter and of the spray booth have been removed for clarity.

Although the flock spraying process is employed to provide an imitation effect—namely, a surface to have the appearance of suede, felt, velvet, or nap—it does serve a really utilitarian purpose, and it does yield coatings that are durable and hard wearing. Moreover, these coatings can by this means be applied to articles which could not by other means be given an alternative surface finish that would do the same job, or at least in an economic

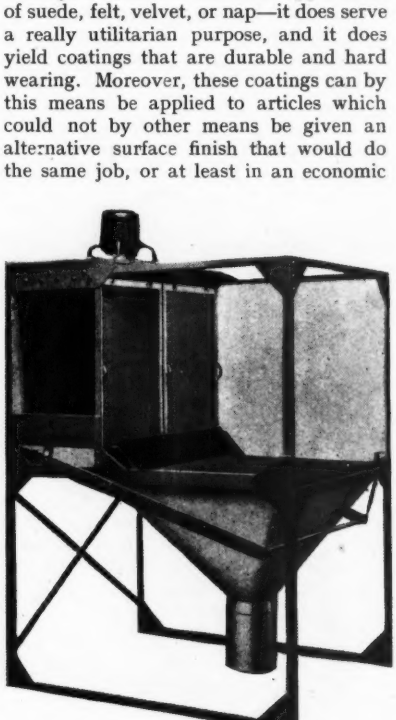


Fig. 10.—"Aerospray" booth for flock spraying.

manner. It is not an expensive finish, nor is it an unduly cheap one. The cost of the medium is of the same order as that of other varnish-like media, namely, in the region of 15s. per gallon, and the price of the flock is in the region of from 1s. to 4s. per lb., cotton being at the bottom end of this range and art silk at the top end. Something of the order of half an ounce of flock per square foot of surface per coat gives some rough idea as to the covering capacity of the material.

Flock spraying has become an invaluable process in numerous applications where a cushioning layer is required. It has proved its worth on apparatus and equipments on areas of which a felt layer has been really essential, but could not be easily and firmly secured. In short, the process has actually solved practical problems. Apart from this aspect, applications for reasons of decorative effect, as on cartons and upon clothing, cannot entirely be ruled out of the utilitarian group, and applications in which felt is directly substituted, for example, felt baize for card tables and for lining cutlery trays, must certainly be regarded as service rendered. In these last cases, it might even be contended that it is more logical to spray adhesive and then flock to give a homogeneously stuck surface of hard-wearing qualities than it is to manufacture felt sheeting, cut it to shape and then fit it by cementing.

Thus it is seen that with the procedure of securing felt by means of cement or adhesive, there is a loss of material in the cutting of the pieces to shape and an intricate operation of fitting, especially if the surface to be covered is not a flat one. This material loss is not incurred when employing flock because all loose flock is gathered up and re-used. Also the tricky operation of fitting does not arise since, provided that the surfaces involved are accessible for spraying, one article is approximately as simple as another to cover by this method. Again, the raw material is much more inexpensive than would be expected at first sight because it can utilize as its starting point what is virtually scrap to other industries, providing a judicious selection is made, and careful hand sorting employed. This can ensure a uniformity of grade, absence of foreign matter, and the use of a magnetic separator guarantees freedom from iron and steel, such as nails and the like, before chopping to length.

Turning now to another aspect of the flock-sprayed coatings, there is the possibility of utilizing them as electrically insulating layers. Unfortunately they are moisture absorbent, as is naturally to be anticipated from their fibrous nature. The undercoating of adhesive renders them rather more insulating through their thickness than is felt in equal thickness, but superficially they are poor under humid conditions. Therefore, even the art. silks should not be relied upon when good characteristics of insulation resistance are important, especially when damp conditions in service are to be encountered. Silk flock coatings have, however, found limited applications in this direction, and there is no reason why they should not give full satisfaction in many instances where at present plain cotton tape is employed without the added electrical reinforcement of varnishing.

There are, however, synthetic resin fibres being produced that may remove, or go a long way towards overcoming, this disadvantage of susceptibility to moisture. They are not at the present time available in this country, or at least not generally procurable without special priority. Of these newer fibrous materials, nylon is probably the first to come to mind. Under normal atmospheric conditions, with relative humidity values of the order of 60 to 70 per cent., the moisture content of the ordinary washed cottons as used in the electrical industries is of the order of 8½ per cent. The corresponding value for wool is somewhat higher, perhaps rising to 12 per cent. Acetate silk shows a lower figure, probably down to 4 per cent. No moisture content value is available just at the moment for nylon fibre, and undoubtedly it would depend, of course, in some measure upon the grade of nylon concerned. However, it is anticipated that it would be lower than that for artificial silk, and that this material in fine fibrous powdered form would yield good electrical values of insulation resistance, even under damp conditions. For the electrical nylons in fibre form, volume resistivity values of 4×10^{14} ohms per cm. cube at 18 per cent. relative humidity, and 5×10^{9} ohms per cm. cube for the fibre saturated with water, have been quoted. From these values and general consideration of the properties of the material, it is thought that the

material offers good promise in this direction.

Another American synthetic fibre or yarn is " Vinyon." This is an unplasticized resin, being the copolymer of vinyl chloride with vinyl acetate. It is said to be completely and permanently water resistant, and to have good electrical properties. Further, it is non-inflammable, and is not attacked by bacteria or fungi and does not support the growth of these. The material has been in use for making fabrics, which, in turn, are employed in the production of wearing apparel, including swim suits. Its water resistance, combined with chemical resistance and toughness, qualify it for this purpose. It is virtually unknown in this country and therefore nothing definite can be stated concerning its electrical properties, but nevertheless the material looks as though it is another possibility for adoption in flock spraying.

The next material for consideration is one to improve upon the present waxes, bitumens and varnishes used for the impregnation of electrical coils, especially for those small coils having fine wire windings. The treatment of such items to enable them to withstand service requirements is a problem of long standing that has not yet been fully solved, even for conditions of operation that are not unduly severe. It might be helpful to preface the subject of solventless varnishes with some very brief notes upon the types of coil referred to, and the service conditions imposed.

Coils of all types that are embodied in electrical communications equipment represent the main, and perhaps the most difficult portion, of the field. Relay windings are generally built on to a soft iron core, the latter being fitted with cheeks to provide a fixed winding space. The cheeks may be of insulating material, moulded bakelite or cellulose acetate, or they may be fabricated from synthetic bonded paper sheet. The core may be " sleeved " with several closely fitting split tubes of nickel/iron alloy. Insulation material of treated paper or fabric-type, or of plastic film must cover the core, and is used as insulation between windings when more than one is wound on the same core/cheek assembly. End washers have to be used behind the cheeks so as to carry lead-out wires between them in sandwich fashion to keep the leads insulated from one another and from the winding itself. The winding wire will be enamel-coated copper wire, but silk or textile-covered copper wire, with or without an enamel coating, may also be used, and again a portion of the winding may be resistance wire, a nickel/copper alloy, with one or other of the above-mentioned insulating coverings. Joins between windings, and at breaks in the wire, will be made by soft soldering or by a fusion welding process, and the junction wrapped in insulating film. The size of the winding wire in general may be of any small gauge down to 47 S.W.G., and even smaller in some cases. The problem of uniform treatment is immediately seen to be an intricate one, with the range of interstices, the variety of raw materials and the fragile nature of the wire.

Similar constructional comments may be made with respect to induction coils, ringer and bell coils, etc., in some of which the winding former may be a moulded spool, which is quite a helpful feature. Small transformer coils may be wound on formers of pressboard, the windings may be paper interleaved, i.e., a layer of insulating material between each layer of each winding, the centre of the core will be packed tightly with laminations of silicon or nickel iron. From multi-tappings, loose lead-out wires will be encased in polyvinyl chloride tubing as insulation.

Apart from electrical stresses, which in many cases will include direct current with a potential between windings and core, the ideal condition to promote electrolytic corrosion, working conditions may embrace one or more of the following:—

(1) Exposure to ordinary indoor atmospheric conditions with possible condensation in " off " periods when cooling down from the temperature induced by operating heat.

(2) Exposure under tropical conditions with wide fluctuations in temperature and humidity, and inevitable condensation of water.

(3) Exposure in the tropics but in air-conditioned buildings that can be maintained dry except when conditioning plants develop a failure.

(4) Exposure to cold, either upon account of high altitude or arctic regions.

(5) Exposure to vibration during operating periods.

(6) Subjection to vibration and bumping in transport.

(7) Exposure to chemically corroding atmospheres, to salt of marine atmospheres, sulphur or hydrogen sulphide near oil refineries, sulphurous fumes in industrial atmospheres, and miscellaneous fumes in the neighbourhood of heavy chemical industries and metal treatment plants.

Space does not permit of examining these points in detail, but, broadly speaking, the winding requires to be encased in insulation of an impervious nature, so that high insulation resistance is retained between windings, and between winding and core, even under the most unfavourable circumstances of dampness. Further, the winding must be rigidly held, even the individual turns of it, if vibration is to be withstood, otherwise abrasion between turns finally results in short-circuiting, and, additionally, wires of the winding may break from chafing or from slipping out of position. This is a common fault with small motors driving units that cause vibration of the equipment as a whole.

Various types of impregnant are employed and they are applied by one of several methods.

Wax impregnation followed by bitumen sealing is one of the most successful procedures. The coils are predried, hot wax is drawn under vacuum into the chamber of hot coils, pressure may or may not be imposed to assist in forcing the wax into the heart of the coil, the wax is drained down and the coils allowed to cool. This may complete the treatment, or sealing by immersion in hot bitumen may follow.

Small coils cannot always be given the bitumen treatment, either because the coils are too delicate or because the bitumen leaves too thick a coating, thicker than can be tolerated for operational reasons. Wax alone on relays is detrimental because under the warmth developed in operating, wax tends to creep and much trouble is experienced from the fouling or sticking of the relay contacts. Again, it is difficult to satisfy temperatures at both ends of the scale, especially when operating heat has to be taken into consideration. The present-day high melting point mineral waxes are very good, and can stand 80 degrees C. without flowing, and minus 40 degrees C. without serious cracking, but these are the outside limits that are likely to be met with waxes, and only just met by selected waxes. Bitumens are rather more difficult, one satisfying 80 degrees C. as the top temperature, probably failing at minus 20 degrees C. by cracking. Again, other difficulties are the possible damage to the enamel on the wire by wax, and damage to insulation by the temperature of bitumen dipping, even if this is a relatively brief period, because something of the order of 200 degrees C. is necessary to render bitumen sufficiently fluid.

Varnish impregnations are used as extensively as wax treatments. They should be vacuum-pressure treatments, with two or three successive impregnations. Two vacuum impregnations in medium thick varnish, followed by a dip seal in heavy varnish, is a good procedure. In fact, with appreciation of the difficulty in removing solvent carrier from within the coil, and the impossibility of achieving oxidation of the varnish in its interior, very good varnishes are being marketed having a thermosetting oil modified synthetic resin base with the minimum of solvent carrier. Such varnishes have a very high viscosity, in the region of 30 to 60 poises at ordinary temperatures. With these one impregnation and one seal suffices.

The general shortcomings of varnishes may be briefly summarized under solvent action upon the enamel of the wire winding, " greening " or corrosion of copper, excessive rigidity causing disconnections in fine wires, due to differential contraction or expansion during cooling and heating, all of which can be overcome by proper selection of the varnish medium; failure to " dry " inside the coil, either due to incomplete removal of solvent or due to incomplete polymerization or oxidation, features that are very difficult to eliminate entirely; and failure to fill the coil interstices completely, partially due to draining out before polymerization, but mainly because of the shrinkage that occurs when solvent is expelled, a drawback that is probably impossible to answer even partially until varnishes without solvent are available. Another general point is the time period and temperature of baking to cure the varnish. In these respects, it must be remembered that fine wire windings can easily be ruptured by expansional changes resulting from excessively high temperature or fluctuations therein.

Alternatively to the vacuum impregnation processes for predried coils, " hot-dip and bake " methods are used, in some cases satisfactorily. In these, the coils from the predrying ovens are immersed in varnish for a short period. They are then drained and baked, usually for a long period at a relatively low temperature. Two or three such treatments are applied. One of the latest practices employs phenolic resin-oil varnishes, giving two dip treatments in thinner media and one in a thick medium. By such processes, the interstices of small coils can be filled and sealed, but the centre of the coil is left weak and dependent entirely upon the maintenance of the seal. Obviously, additional care is needed in selection of the insulating material within the coil, and no plain paper or textile is safe. The use of treated fabrics or papers is dictated, or of plastic film materials, all of which, of course, render the entry of impregnant more difficult.

In specific cases, particularly with " potted " coils, i.e., those in containers, other impregnants are used. Common colophony resin is the base of many of these, with modifying additions such as resin oil and waxes, to offset such shortcomings as brittleness, shrinkage and poor adhesion to metals.

It is for the small coils, relay windings, transformers and the like that solventless varnishes are certainly required. Wax and bitumen can still suffice for a limited field, particularly with potted coils. The ultimate design of coil may be towards a structure favourable for impregnating and sealing with thermosetting solventless varnish, and when additionally useful, an extruded, moulded or pressed outer casing of plastic. At the same time, of course, economics must figure in the picture, and may preclude the adoption of this extreme limit except for severe service in the tropics or under open weather conditions.

The need for solventless varnishes of a thermosetting nature for the impregnation of coils was mentioned as early as 1940 by H. Warren, of the British Thomson-Houston Co., Ltd., in a paper entitled " Insulation," reference " Journ. Inst. of Elect. Engs.," Vol. 87, No. 528, December, 1940, pp. 588 to 596. Using conventional varnishes that require oxygen for the solidification of the drying oil, the outer skin of the varnish hardens, tending to prevent the inner varnish from passing from the liquid to the solid state on account of inaccessibility to air. This liquid varnish is detrimental, as it can "migrate" inside the coil. It may with time tend to soften or dissolve the enamel covering off the wire of the winding, if this is an enamelled conductor, as often in the case; this solvent action is accentuated by any heat which may be produced within the coil by virtue of its service functioning. It may promote corrosion of fine wire windings and therefore premature breakdown. Again, if the coil is part of a high-speed rotary member, the phenomenon generally referred to as "throwing" or "slinging" may be experienced, viz., the outer hard skin of

varnish gives way and liquid varnish is centrifugally thrown out of the coil.

All these disadvantages are known in practice, and one or more of them may occur, however conscientiously processing may have been carried out and however efficiently the operations may have been maintained. Thus, much attention was given to varnishes of the phenol-formaldehyde type because of their thermosetting character. These introduce

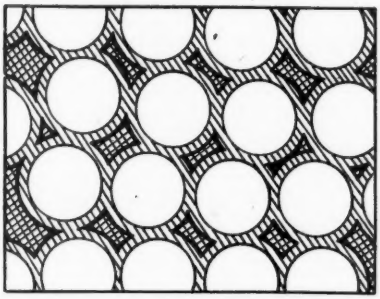


Fig. 11.—Section of varnish-impregnated coil showing voids (dark shading) in background of varnish (shaded).

their own problems. They are difficult to cure in relatively complex coils without blistering and the formation of cavities, and there is some tendency for solvent retention. They set rock-hard and this lack of flexibility is not in accord with the relative contractional and expansional properties of the wire and the cured varnish. Disconnections are numerous, particularly in finer gauges of wire, and these occur not only during processing, but also in service. Also, due to contractional differences, it is quite common to find that the phenol formaldehyde varnish has completely stripped the enamel off some turns or layers of the wire of the winding.

To some extent these difficulties are overcome by the development of more elastic thermosetting varnishes, these being composed of an oil-soluble resin of the phenol-formaldehyde type modified with a thermosetting oil such as china wood-oil. Warren mentions the development of a product of this type consisting of xylenol-formaldehyde blended with china wood-oil. Such varnishes having a solvent carrier are useful, of course, but it is the type without solvent that is desirable for coil impregnation. With proper conditions the solventless type bake to a solid mass throughout, and Warren points out that this solves the problems of the elimination of corona in high-voltage coils when operating at reduced air pressures. Coils impregnated with such media, upon sectioning and examining, show that the interspaces in the coil are completely filled solid, in contrast with the condition of unfilled spaces found when solvent containing varnishes are

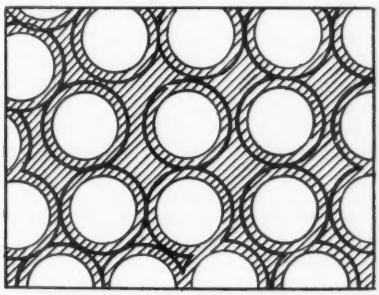


Fig. 12.—Section of coil impregnated in solventless varnish. The spaces between the conductors are homogeneously filled with solid varnish and the primary insulation of the wire is faintly visible as a halo concentric with the section of the conductor.

used. Obviously difficulties are encountered in practice, such as producing varnishes of sufficient fluidity to enter the coil, yet of high enough viscosity not to drain out of it during the baking operation of curing. It is such shortcomings that have been mainly responsible for the lack of exploitation of these varnishes, and it is in this direction that coil design can undoubtedly assist.

Figs. 11 and 12 are reproduced from Warren's photographs. They show microscopic views of sections of varnish-impregnated enamel wire windings. Fig. 11 depicts the result obtained using

an orthodox electrical insulating varnish having a solvent carrier. The light circular areas are cross-sections of the wires of the windings. The shaded areas show the insulation, comprising the original enamel coating on the wire plus the varnish of the impregnation. The irregular dark areas are the voids in this insulation, due to shrinkage when solvent was expelled. Fig. 12 shows quite a different picture when using a solventless varnish medium; the initial enamel covering has a halo around the wire and a uniform background of insulation, with no voids. In fact, the picture gives confidence in the efficiency of the impregnation.

A number of concerns are working upon solventless varnishes in this country, but, so far as is known, nothing has advanced as far as the commercial stage. C. I. Phillips, in his article on "Synthetic Resins in the Surface-coating Industry," "Plastics," August, 1944, p. 355, refers to this type of material, in which the composition comprises a resin in a solvent which itself is polymerizable so that the whole of the composition contributes to the final film. In relation to work already done, Phillips quotes Thiokol (ethylene polysulphide) in allyl maleate.

The former is produced from ethylene chloride by reaction with sodium polysulphide, with the elimination of sodium chloride, viz.—

$$Cl \cdot CH_2 \cdot CH_2 \cdot Cl + Na_2S_4 \longrightarrow -CH_2-CH_2-\underset{\underset{S}{\|}}{S}-\underset{\underset{S}{\|}}{S}-CH_2-CH_2- + 2NaCl$$

The reaction that can be brought about when this Thiokol resin is dispersed in allyl maleate is due to the presence of the sulphur linkages, on the one hand, and the double bonds in the allyl group, on the other. A new resinous product is formed, insoluble and infusible, and having cross-linkages. This example illustrates one channel of research and the underlying principle. Work is apparently proceeding upon thermoplastics, such as the methacrylates and the polystyrenes, along similar lines, and this all calls to mind Warner's recent statement (ref. "Electrical Communication," No. 1, Vol. 22, 1944, "Plastics—a Brief Review of their Physical and Electrical Properties") that thermoplastic resins have a great future, especially in view of the fact that the classification "thermoplastic" and "thermosetting" was becoming less clearly defined, since one could be converted to the other. From the general point of view, of course, these developments are by no means being confined to organic finishing media for electrical coil treatment, but are extended to the finishing field generally, including metalwork, woodwork, etc.

America has produced the solventless varnish for coil treatment, and it is in commercial use for impregnation and for the outer sealing of small coils. This success has to be credited to the Westinghouse Research Laboratories, who have developed a range of such synthetic varnishes, known under the descriptive term of Fosterite. This was first made known at a symposium on plastics and briefly reported in "Electrical Engineering," July, 1944. A more detailed account of these products was published by Dr. C. F. Hill, manager of the insulation department of the Westinghouse Electrical Co. in an article in "Plastics," November, 1944, p. 515. Those interested in the subject should consult this article for details.

The American solventless varnishes, "Fosterites," answer the requirements for coil impregnation and sealing. It is stated that Fosterite at the impregnation stage is a liquid medium, but when subjected to a baking process the liquid carrier reacts with the resin which it contains in solution, and the mixture converts to a tough solid. No by-products are formed in this reaction, a very important point to note; an analogy with Phillips's example can be drawn. Obviously, any such mixture that caused water to be formed during the condensa-

tion of the two ingredients would be condemned for insulation purposes. Again, it is to be noted that the reaction involved is not akin to the quick hardening of thermosetting resin mixtures in the presence of an acid hardener; a reaction that obviously could not be permitted within an electrical coil winding.

These Fosterite varnishes are claimed to fill coil windings perfectly, with the result that more uniform dielectric stresses within the coil are achieved. As a result, more uniform heating and better dissipation are secured, and higher electric stresses can be imposed or smaller units designed to perform the same purpose. The impregnant holds the winding firmly, and, when used as an outer seal, the coating is tough and extraordinarily adherent to metal. A very good mechanical protection to the coil is thus provided. Further, the Fosterites are stated to possess excellent properties of moisture resistance and impermeability, and therefore they provide an answer to the coil problem of tropicalization.

The compositional nature of the Fosterite varnish is at present secret, as can be well understood, and no information has been published concerning the methods by which it is used for coil impregnation and sealing. It is probable that the varnish is not stable, due to a tendency to polymerize at ordinary temperatures. This is no drawback in itself, because the ingredients can be mixed as used. Nevertheless, it can be expected that some troubles and difficulties will be encountered under processing conditions due to a tendency to polymerize in pipelines and tanks. Troubles may still be encountered with draining from the larger interstices of coils before polymerization is complete. These points are mentioned because Fosterite is undoubtedly a big advance in this field and, while it serves an essential purpose satisfactorily, it must not be assumed that all difficulties are ended. Technicians are anxiously looking forward to the availability of this class of material in this country: it is the first of a series that promises to go a long way not only in this connection but in all metal-finishing problems.

THE LORIVAL ACID BUCKET

It is good to see that this bucket, the appearance on the market of which we praised highly some two years ago, has received the success it deserved.

We have received a photograph from Mr. K. R. Dodd, of United Ebonite and Lorival, Ltd., of Little Lever, near Bolton, showing the latest improved type; a pouring lip has been provided in this resin casting. For the benefit of those numerous industries which employ acids and which range from galvanizing and fertilizer manufacture to tanning, pigment production and electroplating, we would point out that this bucket is of cast-phenolic resin, which can replace the old type of rubber bucket for the carrying of hydrochloric and sulphuric acids, cold and hot. Organic acids, too, have no effect on the material, nor has benzol, carbon tetrachloride, and acetone.

Apart from liquids, the bucket is also suitable for carrying acidic salts such as calcium chloride, zinc chloride and so on.

World's Industry Employs Plastics

GENERAL ENGINEERING

Abrasive sticks of new design for honing operations on cylinder bores are moulded into a thermosetting resin; a tab of plastic without abrasive extends beyond the end to permit of automatic sizing control. When the honing stick comes to the end of the stroke the tab enters a ring gauge built into the machine. (Machine Tool Blue Book, 1945/41/135). **Grinding wheels** for sintered carbide tools contain silicon carbide in a resinoid bond. They are said to give improved performance as compared with the usual vitrified wheels (Electro Refractories and Alloys Corporation, Buffalo, New York). **For material handling equipment** a cushion-type rubber tyre 6 ins. in diameter and 2-in. face width has been introduced. The tyre is held in position by two locking hub plates of magnesium alloy, the hub itself being fitted with roller bearings. ("Machine Design," 1945/17/156). **"Marcolite,"** a thermosetting laminated plastic, is supplied with fibre-glass or cotton duck fillers, either separately or in combination. It is produced in thicknesses from less than 0.01 in. up to 3 ins. and may be used in flat sheet form or moulded to any shape and to sharp corners. The abrasion resistance of the material is said to approach that of porcelain. It has proved satisfactory for use within the temperature range −70 degrees F. to +700 degrees F. ("Automotive and Aviation Industries," 1945/92/112.) According to "Automotive and Aviation Industries," 1945/92/120, **Vibron resins,** when combined with spun glass, are capable of reaching tensile strengths equivalent to that of steel. Ranges of physical properties, such as hardness, flexibility and abrasion resistance, can be controlled by selection of the precise type of resin. **Induction heating** to obtain more rapid production is employed in connection with a 75-ton vertical hydraulic press used for plastic moulding at the Baldwin Locomotive Works, U.S.A.; 20 per cent. increased production was obtained from an experimental six-cavity mould, this being a better performance than that previously yielded by a standard 24-cavity mould. Moulds for induction heating have a 30 per cent. longer life and 12½ per cent. plastic is saved as a result of reduction in flash and rejects. ("Machinist," 1945/89/243.)

ELECTRICAL

Moisture absorption, electrical characteristics, physical properties, brittleness range and accelerated ageing have been investigated on GR-S by the Bell Telephone Laboratories (Bell Laboratories Record, 1945/23/209). **Special technique for X-raying thermosetting plastics** is described by Amido of the Delco Appliance Division, General Motors. Several examples are given of components with metallic inserts and possible faults are discussed. ("Industrial Radiography," 1945/3/21, Spring Issue). **The design of a movable insert** and movable loading and locking rings for a plastic moulding operation, which included the moulding-in of a large number of small copper contacts, greatly facilitated handling and diminished production time, according to Wessel in

" Machinist," 1945/89/309. It was demonstrated by Schori Metallizing Process, Ltd., many months ago, that polythene could be sprayed through the Schori powder pistol, according to " Scientific American," 1945/172/340. Dupont de Nemours have now also made the same observation. Applications envisaged by Dupont are the covering of contacts of electrical apparatus for insulating terminals, and also for repairing damaged equipment without need for dismantling.

AIRCRAFT

Bullet hole patching device produced by the United States Rubber Co. consists of a ring in a spongy synthetic rubber used in conjunction with a patented spring clamp. The ring itself is resistant to both oil and petroleum spirit and will deflect to any shape. (" Automotive and Aviation Industries," 1945/92/76.) **Emergency life light** by G.E.C. floats on water and is supplied with power by a dry battery. It is housed and sealed in a transparent dome moulded from a shatterproof plastic. Life jacket lamps are moulded both of red and clear transparent Tenite.

MOTORS

Distributor cap nipples require material of high elasticity and good insulating properties. In particular such material must be immune from attack from ozone. Vinylite has been shown satisfactorily to withstand high ozone concentrations for six hours under operating conditions, whereas natural rubber and most synthetic rubbers fail completely under similar tests. (" Machine Design," 1945/17/140.)

FANCY GOODS

Two new British Standards, 1,203 and 1,204, on synthetic resin adhesives for wood have recently been issued. They deal with phenolic and amino plastic adhesives both cold and hot setting. Appendices on recommended tests are included. A draft specification has also been circulated dealing with plastic mouldings to which the B.S.I. certification mark may be applied. Each contains, in particular, recommendations for plastic table ware and various stores.

MISCELLANEOUS

Records 7 ins. in diameter in waferthin vinylite can take 15 minutes' dictation and 100 discs can be stored in a depth of 1 in. U.S. Army and Navy Signals are using this device at present for vital communications. (" Scientific American," 1945/172/298.) **Vinyl plastic scrap** available from the manufacture of insulated wire has been employed in U.S.A. for manufacturing soles of shoes. The National Bureau of Standards investigated 22 vinyl plastic materials of this type for density, tensile strength, extensibility, stitching quality, tearing properties, the swelling on immersion in water and loss in weight on heating, fatigue properties at 32 degrees F., resistance to cracking on bending in the range 0 degrees to -20 degrees F. and $+40$ degrees F., and abrasion resistance. The materials proved inferior to leather in tensile strength, stitching qualities and tearing properties, but superior with respect to water absorption and abrasion resistance. Minimum requirements for physical properties were

determined. ("Technical News Bulletin," 1945/p. 31.) **New design face shield** in transparent plastic is of such length that it fits against the operator's chest to prevent flying particles entering from below. Any type of headgear can be used and soft leather sweat band is usually supplied, together with a readily changeable face visor. ("Machinist," 1945/89/312.) **Chain theory of synthetic rubbers** is presented in simplified form by Baker in "Bell Laboratories Record," 1945/23/98. Special reference is made to those types used for cable insulation. **Raw materials for plastic and synthetic rubbers** are reviewed by Howart, "Chemical Age," 1945/52/515; 537. Benzole recovery, calcium carbide and the olefines are particularly referred to. The last instalment of the account deals with the economics of the use of coal, secondary products from oil refining and general conclusions. A list of 20 more references is given. **Bathroom and kitchen plumbing** fixtures, including taps, spray nozzles, mixing nozzles, drain connections are, according to the Crane Co., to be introduced on an ever-increasing scale in post-war domestic assemblies. ("Scientific American," 1945/172/344.) **Electrically heated steam generator,** designed for use in connection with individual plastic moulding presses, has been developed by the Vaportron Corporation. It is said to save considerably in the costs for plastic moulding. ("Scientific American," 1945/172/344.) **Release of neoprene** from war demands will bring greater durability to many household products, such as sponge cushions and mattresses, rubber tile-like floor materials, carpet backing, etc. ("Scientific American," 1945/172/236.) **Fabric-base phenolic fibres** are vested with greater elasticity by the adoption of a special weave for the base material. Rapid production is claimed for this latter, known as Phenolastic. **Printing plates** in vinylite are being used for the foreign editions of "New York Times," "Chicago Tribune" and "Newsweek and Times" (U.S.A.). The picture division of the Office of War Information sends to outposts all over the world 22,657 plastic plates a month for foreign reproduction. Runs of 250,000 to 350,000 are being achieved, and the plates are easily stored and transported. ("Scientific American," 1945/172/366.) **Progress in production and application of plastics,** including polythene, polystyrene, polyvinyl chloride, laminated urea resin plastics, improved phenolic laminates, nylon, and the synthetic rubbers (including bonding materials for synthetic rubbers and metal), are covered in a general article by Williams in "Mechanical World," 1945/117/371. **History of plastics** is retold in an illustrated account by Breskin in "Scientific American," 1945/172/269. The account commences with the development of cellulose nitrate plastics by Hyatt, the use of shellac by Berliner, and, of course, the work of Baekeland on the phenolic resins. The wide range of modern synthetics is then touched upon. The account ends with a forecast that wise designers will in the very near future envisage more and more the combination of plastics and metals, taking advantage of the divergent properties of each. **Recent practice of hot forming phenolic laminates** utilizing high temperature pliability characteristics to permit the shaping of these materials in the cured state is fully reviewed by Guhl in a recent paper before the American Society of Mechanical Engineers. (Abstracted in "Mechanical World," 1945/117/545.) **For cementing various combinations of cured and uncured Neoprene stock,** natural rubber, leather fabrics and paper, a new-type plastic adhesive has been developed by du Pont de Nemours and Co. A practical folder containing copies of materials work sheets has been published by "Machine Design"; besides numerous metals, the sheets include laminated phenolic plastics on paper and fabric costs. **The design of extruding dies for cellulose materials** is dealt with by Lawson, who recalls that the processes of extrusion is due to Hyatt, who invented celluloid, the first of the cellulose-base plastics, in 1872. ("Tool and Die Journal," Vol. 10/1945/March, p. 120.)

Vibratory Grinding of Macromolecular Substances

By Dr. ERWIN STEURER,* of the Forschungsinstitut Hess im KWI. für Chemie, Berlin-Dahlem

EXPERIMENTS carried out with super-grinding of material of high molecular weight lead to the remarkable result that the effect of grinding is not only a purely mechanical breaking-up of the material in the sense of a comminution of the coarse grain or fibrous basic material but that also very pronounced chemical changes of the attacked molecules can be observed. This effect is clearly shown by a considerable reduction in viscosity of the basic material. P. Wäntig[1] had already observed in 1927 that cellulose fibres undergo, by dry grinding in a ball mill, a change which results in a considerable decrease in viscosity when brought into xanthate solution form. Later on other authors have found a decrease of viscosity in the grinding of polystyrene,[2] starch,[3] and cellulose derivatives.[4] They have proved by this fact that we have to deal here with an effect which is characteristic for the whole group of organic high polymers.

These experiments did not yield a clear statement on the origin of such a decomposition, since from the orthodox conception of kinetics regarding the transfer of energy required for a reaction in the case of fast-moving or oscillating molecules, a mechanical disintegration caused by impact of the balls is not clearly comprehensible. In the first place, it seemed doubtful whether a breaking up of molecular bonds by merely mechanical treatment was possible at all, and, furthermore, whether the cause was not merely due to secondary influences, such as heating by friction, oxidation from atmospheric oxygen or hydrolysis.

Systematic experiments have been carried out recently regarding the influence of the grinding process on the properties of cellulose and polystyrene. These investigations, together with an examination of the basic energy relations of such "grinding reactions,"[5] justified the assumption that comminution by grinding can be considered as a chemical operation for the decomposition of a compound comparable with other reactions, such as hydrolysis, oxidation and heat treatment. It still remains unexplained how the transfer of the mechanical energy of motion of the balls into oscillatory energy of the molecules occurs, and in which way a demarcation line can be drawn between the local excitation of a group of molecules by ball impact and the "distributed" thermal excitation which occurs in the course of the ordinary heat treatment of a material.

Apart from determining the viscosity and particle weight by the osmotic method, Hess and co-workers established the following properties of the material in order to investigate the mechanism of the grinding process:—

(a) Size and shape of the particles by ordinary optical and electron micrographs.[6]

(b) Lattice structure and lattice energy (by X-ray diagram). Heat of solution and heat of wetting respectively.[7]

(c) Capacity of adsorption (by Congo Red isothermals).[8]

(d) Reaction—Kinetics for the system cellulose/hydrochloric acid in the liquid state.[9]

(e) Swelling capacity.[10]

The laboratory model "Vibratom" developed by I.G. Farben Industrie A.G.[11] was used as a vibratory grinder. The

* Translated from Die Chemische Technik, 1943/16/1-3. Précis of a lecture held before the Besirksverband des VDCh in Danzig on June 5, 1942.

Fig. 1.—Electron optical micrograph of a cellulose ground in a vibratory mill. Breaking-up of the fibril bundles into basic fibrils.

mechanical theory of operation of this mill was first evolved by D. Bachmann.[12]

It has been found that vibratory grinding produces two distinctly different effects:—

(a) Effects of a mechanical nature on the structure of the material. In the case of natural high polymers, such as cellulose, these lead to an opening up of the micellar structure, which would not otherwise be observed. Changes in the natural arrangement of the molecules in the coherent regions are also observed.

(b) Vibratory grinding, furthermore, has a profound effect on the molecules, resulting in changes of properties comparable only with other chemical breaking-up reactions.

We can refer only in passing to the individual results; in particular, those regarding the morphological structure of natural fibres.

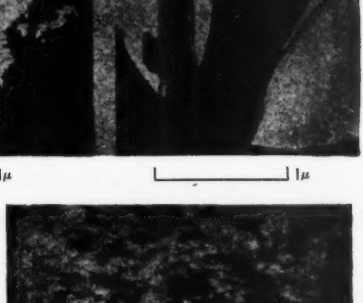


Fig. 2.—Electron optical micrograph of a cellulose ground in a vibratory mill. Breaking-up of bundle of fibrils. 1μ

Predominantly Mechanical Actions

Examining ordinary optical micrographs of cellulose, even after sustained grinding, one can only distinguish irregularly shaped particles of the size of 1-10 microns. Using electron micrographs of the ground powder, however, it is possible to observe particles of a size below one micron, which, in turn, show a still more detailed structure on account of the higher magnification. The size of the smallest particles which can be recognized in Fig. 1—the so-called basic fibrils—is of the order of 150 Å, while the length varies and depends on the grinding time. The basic fibrils which can be recognized in Fig. 2 have a length of approximately 2,500 Å, so far as they are still in the fibre bundle which has not yet been severely attacked. In places where loosening has taken place a further sub-division into particles of 400 Å becomes visible, a value which coincides with the chain length of the same material determined by means of viscometry. It appears that the electron micrograph shows relations between the size of the secondary particles (fibrils) and the length of chain molecules. One might be disposed to explain this fact in the sense of a mechanical splitting into molecular regions. Figures and data available, however, are not sufficient to make an assumption about the quantitative relations between grinding action and breaking up of molecules.[13]

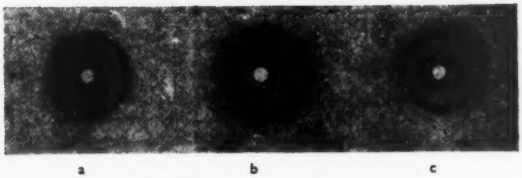


Fig. 3.—X-ray spectrogram of a ground material (b) in comparison with the untreated original cellulose (a) and the material following recrystallization with hot water (c).

A phenomenon which is characteristic for the mechanical action of the grinding process is the break-up of the lattice structure, which has been observed in a large number of substances with both high and low molecular weight.

Fig. 3 shows the X-ray diffraction diagram of a ground cellulose and one with the same material unground. It will be seen that the main interferences have disappeared and that only a broad, indistinct interference pattern remains, which is normally shown by amorphous substances. The treatment of lattice-distorted cellulose with water (even at room temperature, but preferably at 100 degrees C.) causes recrystallization to cellulose hydrate (Fig. 3, right-hand picture).

The considerable changes of the inner lattice structure of materials indicated in the X-ray diagrams are the cause of variation in the energy content between unground and ground samples. This variation becomes conspicuous when determining the heat of solution or heat of wetting respectively. In the case of cane sugar, for instance, grinding results in an increase of molar heat of solution of + 3 kilo. cal/mol., i.e., the change in energy content of the ground sample compared with the unground sample is of the order of the molar heat of fusion. According to this, the energy content of super-finely ground sugar corresponds approximately to that of molten sugar. In the case of heat of wetting of ground cellulose, increases of energy content of the same order can be observed.

It can be stated, therefore, that the purely mechanical action of vibratory grinding does not only cause a reduction of particle size in the colloidal range, as shown in the ordinary optical and electron micrographs, but is also able to induce changes in structure in the micellar and molecular regions respectively, requiring an energy of approximately 5 kilo. cal/mol.

In the range of predominantly mechanical actions of grinding, which are closely correlated to particle reduction and lattice disturbance, one should also mention the observations on the increase of adsorption capacity, on the increased velocity of reaction of cellulose with liquid hydrochloric acid, as well as the increased capacity of swelling and solubility. In the case of reaction velocity and solubility, there is present, however, a superimposed influence of simultaneous reduction of the chain length of the molecules.

Chemical Action

The quite definite strong chemical action of vibratory grinding expresses itself clearly in the viscosity change of materials. This is characterized, for instance, in the case of grinding fir pulp (Fig. 4) by the fact that at the beginning of the grinding a pronounced reduction of viscosity occurs. After

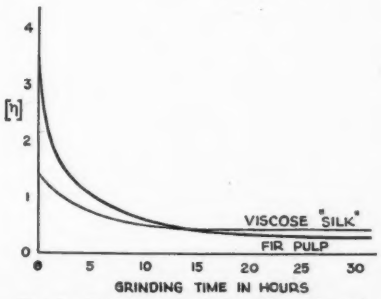


Fig. 4.—Grinding of cellulose (fir pulp and rayon). Viscosity plotted against grinding time, determination in a cuprammonium solution.

approximately 20 hours of grinding a final state is apparently reached where the viscosity decreases only very slowly with continued grinding. Other kinds of cellulose (ramie, cotton, wool), derivatives of cellulose (methyl-, ethyl-, acetyl-cellulose), as well as artificial high polymers (polyvinyl alcohol, polyvinyl acetate and polystyrene) show the same basic picture of a decrease in viscosity less pronounced with increasing grinding time. Table 1 lists the particle size of polystyrene determined by osmotic methods. These figures show that independent of the viscosity, the grinding actually results in a chemical decomposition of polymer chains by prolonged grinding of cellulose samples, the smallest particle size obtained so far is approximately M = 7,800 (degree of polymerization P = 44), corresponding to a viscosity value of $(\eta) = 0.20$; the molecular weight of the original sample was M = 290,000 (P = 1,780), corresponding to $(\eta) = 8.13$. The reduction in particle size obtained by grinding is thus considerable. It cannot yet be stated whether by further grinding or by the use of higher impact intensity of balls, a further reduction might be possible. It seems to be important to determine whether there is, indeed, a limit of grindability, or whether it is possible to change in a chemical sense materials with low molecular weight by the grinding process, provided the grinding time is sufficiently extended.[14]

Table 1.—Particle Size (Molecular Weight) of Polystyrene in Benzene after Vibratory Grinding, determined by Osmotic Method.
P = Osmotic pressure, c = concentration, M = molecular weight.

Duration of grinding in hours	P/c	M
0	0.040	455,000
8	0.080	230,000
16	0.110	165,000

Staudinger and co-workers[15] have tried to answer the question of how far the above-mentioned chemical action of grinding can be explained by secondary chemical influences such as oxidation and heat treatment. They investigated the grinding action with polystyrene and cellulose in a nitrogen atmosphere, adding water in order to prevent overheating. Even with these precautionary measures they observed a considerable reduction in molecular size. Experiments with the vibratory mill carried out by the author have confirmed these observations.

Since it is very difficult under conditions normally existing to exclude atmospheric oxygen entirely,[16] Hess, Steurer and Fromm have used another method which consisted in the determination of the temperature coefficient of the activating heat, in order to examine the lowering of viscosity in the vibratory grinding process. According to these experiments, cellulose, as well as polystyrene, in the region between 0 degree and 90 degrees C. and 20 degrees and 60 degrees C. show that the grinding action is completely independent of temperature. In other words, the activating heat of the grinding reaction practically equals zero, in contrast to the activating heat for hydrolysis, oxidation and thermal reduction, which are of the order of 20/30 kilo. cal/mol. The inference can be drawn that reduction by grinding is an independent process comparable with, but quite independent of, hydrolysis, oxidation and heat treatment, i.e., the grinding reduction is primarily based on an activation and splitting of molecules by the grinding action proper. The grinding action is thus in the same category as photochemical comminution,[17] which also requires a very small activating energy. In the case of both reactions, the splitting process is not caused by the part of energy transferred by the fast-moving or oscillating molecules according to the existing Maxwell distribution of energy, but is controlled by external excitation, by light quanta in the first case and by ball impact in the latter instance.

Relations Between the Forces Existing in the Vibratory Mill and the Molecular Energy Content of the Ground Materials

It is to be expected that the forces obtained in a vibratory mill are of an order exceeding the operative forces in

the molecules, provided that the basis of the grinding operation is a specific mechanical excitation process. Hess, Steurer and Fromm have been able to verify quantitatively the number of split bonds obtained experimentally, by estimating the compression stress caused by the ball impact and by making special assumptions regarding the distribution of material over the ball surfaces. They have thus proved that there is a relation between the grinding energy of the balls and the energy required for separation of the molecules.

Balance of Energy

In order to arrive with some accuracy at a balance of energy between available and required amount of energy, the impact value W available per ball impact, has been compared with the work of separation (A_T) which has to be expended per impact. The work of separation (A_T) is arrived at from the known chemical work of separation per bond of C-C molecules as: $A_0 = 4.85 \times 10^{-12}$ erg per separation and the number of main valencies separated per ball impact ϕ as $A_T = A_0 \times \phi$. The value ϕ which is called the impact yield is arrived at from the number of bonds Z, separated in a given time t, and the number of ball impacts S, occurring during the same period $\phi = Z/S$ where ϕ can be determined from the decrease in viscosity or alternatively the reduction in particle size by the osmotic method. S is derived from the kinematics of the balls in the grinding chamber. This point will not be dealt with in detail. In the case of cellulose, for instance, with a grinding period of t = 300 minutes and a reduction of viscosity from $(\eta)_0 = 3.27$ to $(\eta)_t = 1.53$, the number of split bonds $Z = 3 \times 10^{19}$ and the number of ball impacts $S = 7.51 \times 10^{8}$. From this follows the average impact yield $\phi = 4 \times 10^{10}$ separations per impact. The work required for splitting A_T will be:—

$A_T = A_0 \times \phi = 4.85 \times 10^{-12} \times 4 \times 10^{10} = 0.194$ erg/impact. Compared with this the impact energy of one ball W = 1,510 ergs per impact is available.

It can be stated, therefore, that the available impact energy exceeds considerably the work required for splitting, and is in itself sufficient to effect the splitting of the bonds. Only a minute fraction of the available energy, approximately $A_T/W = 1.28 \times 10^{-4} = 0.0128\%$ is required for the intrinsic work of splitting. The rest is used up for elastic deformation of the balls and of the grinding vessel walls, of the material to be ground, in permanent deformation as well as comminution of the material without splitting of main valencies by merely overcoming van der Waal's forces.

From the point of view of energy, therefore, the splitting of numerous C-C bonds can be easily understood. However, the balance of energy alone does not state whether the available energy is actually capable of generating compression stresses which are sufficient for a splitting of bonds.

Atomic Forces and Compression Stresses

The required stress of splitting of a cellulose molecule can be worked out from the work of splitting A_0, and the separation distance of 0.68 Å arrived at from the potential curve of the molecular tearing process. This equals $\sigma_T = 3{,}100$ kp/mm² for a cross section equal to that of a basic cellulose molecule.

In comparison, an average available compression stress caused by the balls $\sigma = 100$kp*/mm² has been calculated for the vibratory mill which was used. This value has been derived by means of the Hertz theory of the elastic ball impact. Considering the above-mentioned impact stress W for the various positions of the balls in the mill, values of compression stress between 70 and 140 kp/mm² have been calculated. Still smaller values of compression stress of 40/50 kp/mm² are obtained if one takes into consideration the reaction to the compression stresses of the material adhering to the balls. H. Fromm has examined this reaction for a given distribution of material by means of a compression theory applied to two

* kp = kilogram weight.

elastic balls with an elastic intermediate layer.

Discussion of Compression Stresses

According to the above, the compression stress required for a splitting of bonds is far from being reached. The available compression stresses would only be sufficient to overcome van der Waal's forces, to reduce the grain size and to distort the lattice. In order to remove this discrepancy, an assumption was made regarding the distribution of the material over the ball surface; it has been verified by experiments.

If one assumes that the pressure area between the balls is only covered with material to a small fraction intermittently, a concentration of compression forces is bound to occur at the individual coating areas. This concentration increases the compression stresses in the material up to the required stress of splitting. A stress which is distributed over the pressure area F is bound to result in an effective stress $\sigma_w = \sigma/\alpha$ where $\sigma_w = \sigma_T$, if concentrated on the summits of particles. The factor α, i.e., the coating density of the balls in the above-mentioned case ought to be .01 – .02, in other words, 1-2 per cent. only of the ball surface should be covered with material.

An experimental examination of the coating density has shown that the primary requirements of the theory regarding an intermittent coating of the surface is fulfilled, but that the mass of substance adhering to the balls is, on an average, considerably greater than should be expected from the theory. Resulting from this, it has been found necessary to distinguish between a true and an effective coating density. The effective coating density refers to the summits of the particles of material adhering to the balls.[18]

Theory and experiment, therefore, lead to the same conclusion, viz., the mechanical excitation by ball impact is the direct cause of the oscillatory process responsible for chemical decomposition.

A closer analysis of the kind of oscillations excited in solid bodies, their energy distribution in the impact area and the transfer of energy prior to and following the splitting of valencies will have to be carried out.

Conclusions

A systematic examination of the grinding process in the vibratory mill is of general interest since, in chemical reactions of macromolecules (particularly in technological processes), mechanical actions, such as stirring, breaking-up, grinding, kneading, rolling, etc., are frequently used. This research should help to lay a foundation in order to distinguish more rigorously between chemical and mechanical actions.

REFERENCES

(1) *Kolloid-Z.*, 1927/41/152. **(2)** *H. Staudinger and W. Heuer; Ber. dtsch. chem. Ges.*, 1934/67/1,159. **(3)** *L. H. Lampitt, C. H. F. Fuller and N. Goldenberg; J. Soc. Chem. Ind.*, 1941/60/1. *Chem. Ztrbl.*, 1941/11/2,504. **(4)** *H. Staudinger and E. Dreher; Ber. dtsch. chem. Ges.*, 1936/69/1,091. *E. Steurer; Z. physik. Chem. Abt. B.*, 1940/47/143. **(5)** *K. Hess, E. Steurer and H. Fromm; Kolloid-Z.*, 1942/98/148, 290. **(6)** *K. Hess, H. Kiessig and J. Gundermann; Z. physik. Chem. Abt. B.*, 1941/49/64. **(7)** *J. Grundermann; Kolloid-Z.*, 1942/99/142. **(8)** *K. Hess and W. Gramberg;* 1941/*ibid.* 97/87. **(9)** *M. Ulmann and K. Hess; Ber. dtsch. chem. Ges.*, 1941/74/1,465. *M. Ulmann; Kolloid-Z.*, 1942/98/100. **(10)** *W. Wergin; Kolloid-Z.*, 1942/98/131. **(11)** *S. Kiesskalk; Z. Ver. Dtsch. Ing. Beih. Verfahrenstechn.*, 1936/1. **(12)** *Z. Ver. dtsch. Ing., Beih. Verfahrenstechn.*, 1940/43. *See also this journal*, 1942/15/195. **(13)** *A detailed examination of this relation should contribute towards the question of relations between chain length and viscosity, a matter which is still under dispute.* **(14)** *We shall report in due course about experiments carried out in order to clarify this point.* **(15)** *Loc. cit.* **(16)** *Regarding the determination and removal of small amounts of oxygen see: E. Steurer and W. Mertens; Ber. dtsch. chem. Ges.*, 1941/74/790. **(17)** *E. Steurer; Z. physik. Chem. Abt. B.*, 1940/47/127. **(18)** *See also the report to be published shortly by Hess, Steurer and Fromm in Z. physik. Chem. Abt. B.*

The Microscopic Examination of Plastic Materials

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

DURING the past 20 years or so, the use of the microscope in industry has been wide, and is now looked upon by a number of industries as an essential piece of apparatus for laboratory and research purposes. Its usefulness and the accomplishments which may be credited to it, as an instrument of the highest precision, undoubtedly bear witness to its increasing importance as a diagnostic and research instrument, and when it is appreciated that there is not a single phase of industrial development or mode of life that has not benefited from its use, it is surprising that more evidence of its use in the plastics industry has not come to light; this industry, with its enormous field, extending from the raw materials to the final moulded materials and ancillary manufactures of fillers, paper, varnishes, etc., truly offers a wonderful field for the use of the microscope both in control and development work.

If we include such substances as glass, wax, and fibre in the generic term "plastics," then there is no doubt that the microscope has been used for the examination of plastic materials for a long time, for the checking of optical glasses with the aid of polarized light and for examining the structure of natural waxes and textiles many years ago. However, as the term to-day is almost exclusively applied to plastic substances of synthetic origin, it would appear that the use of the microscope has been woefully neglected; the general absence of the publication of the results of such work justifies the statement.

The skill displayed by the user of the instrument and the correct interpretation of the images seen determine the reliability of the results obtained. There is nothing, it is true, to prevent anyone purchasing such an instrument, placing it on the laboratory bench or office table and using it merely to look at various specimens, thereby gaining little, if any, knowledge, but being in a position to say, "I use the microscope." There is, in fact, a world of difference in using the microscope as a highly accurate scientific instrument, on the one hand, and as a mere magnifying glass, on the other. As a matter of fact, a sixpenny lens is often capable of divulging more information than an expensive and elaborate microscope, if the latter is not used in a fit and proper manner, and the number of cases in which this instrument is so abused is truly regrettable.

As the purpose of these articles is to demonstrate ways and means of applying scientific microscopy to the study of plastic materials, the serious user must have at least the basic principles of microscopy at his finger tips. It is intended to deal very briefly in a future article with methods of preparing specimens for examination and methods of setting up and using the instrument.

It has been the author's good fortune for a number of years to be in a position to use the microscope as a part of his daily tasks. It is actually used in the author's laboratory for several different purposes, ranging from the examination of metallurgical specimens to the identification of bacteria in the scum of the cutting lubricant used in machine tools. However, for the past three or four years it has been in constant demand for the examination of plastic materials as used by the electrical industry. These, of course, comprise such substances as

phenolic mouldings and resin-bonded paper and fabric materials in the form of rod, tube and sheet, in the thermo-setting class, and such substances as polythene, both as such and as part of a mixture, mica-loaded polystyrene, and last, but not least, the newer synthetic wire enamels, occasioned much research and brought to light a wealth of interesting information.

The foregoing materials will all be dealt with in this and subsequent articles, as a result of which it is hoped to show that the microscope is not an instrument to be taken lightly or used as a novel toy. Therefore, these following observations and results are offered in the hope that they may be the means of stimulating interest, resulting in the more general use of the instrument in the plastics industry, and more particularly in those of its branches involving the production and development of resins and their fabrication into the finished materials.

It is highly probable that the first instance of the employment of the micro-

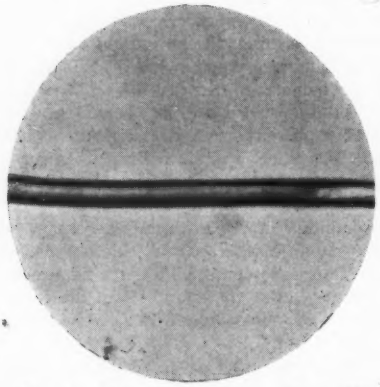


Fig. 1.—Natural silk fibre. Mag. 320 diams. Polarized light, system partially crossed.

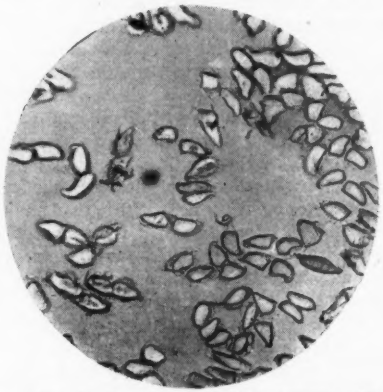


Fig. 2.—Transverse section natural silk. Mag. 320 diams. Taken with polarized light, the system partially crossed.

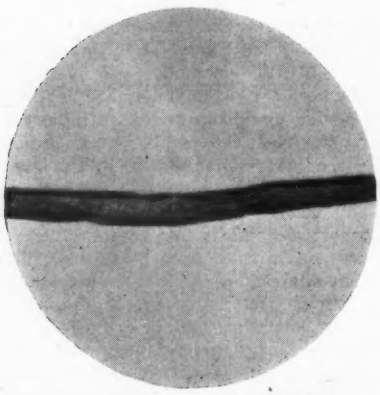


Fig. 3.—Cotton fibre. Mag. 320 diams. Taken with polarized light, the system partially crossed.

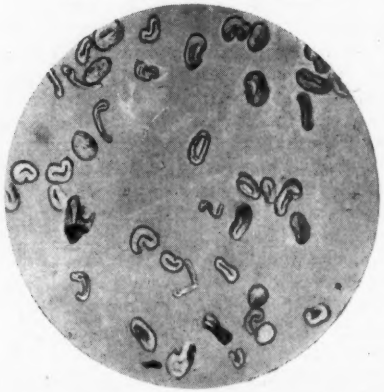


Fig. 4.—Transverse section cotton fibres. Mag. 320 diams. Taken with polarized light, system partially crossed.

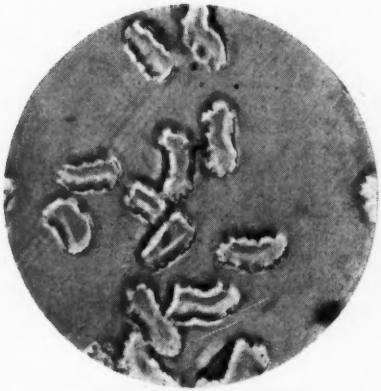


Fig. 5.—Transverse section viscose fibres. Mag. 320 diams. Polarized light, system partially crossed.

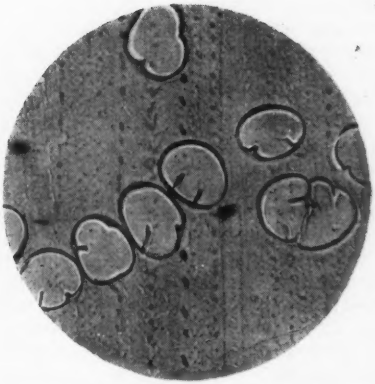


Fig. 6.—Transverse section cellulose acetate fibres. Mag. 320 diams. Polarized light, system partially crossed.

scope in the plastics industry in its widest sense occurred many years ago, when it was used in the examination of artificial silk fibres; indeed, this is understandable, as most of the people employed in the artificial silk industry also had some knowledge of the natural textile industry; in fact, they were very likely drawn from this latter, in which the microscope was already in use for the examination of textile fibres.

The two most widely used of the natural fibres are cotton and silk. Figs. 1 and 2 show the whole natural silk fibre and the fibres in transverse section, while Figs. 3 and 4 show the same for cotton. The important points to note about these photomicrographs is that they show the natural silk to be a solid fibre of roughly triangular cross section, whereas the cotton fibre is shown to be a collapsed tube, the wall of which is composed of cellulose. This latter fact has an important bearing on the manufacture of laminated materials, as we shall see at a later stage.

Now, let us leave the natural fibres for the time being and examine instead the artificial fibres. The microscopy of rayon is complex, each type of fibre, whether viscose, cuprammonium or cellulose acetate, possessing definite physical characteristics which serve to distinguish it from the others. Their shapes in cross section are characteristic, so much so that, by studying the minute differences in any one particular type, one may often identify the source of any given sample. Fig. 5 is a photomicrograph showing typical viscose fibres, the general shape of the cross section clearly shows they possess an irregular crenated edge,

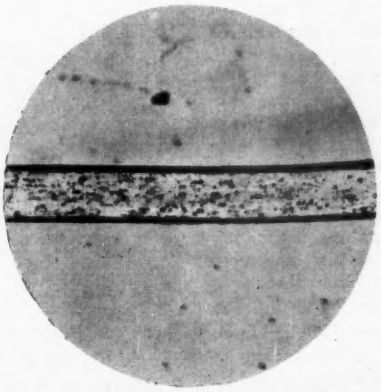


Fig. 7.—Nylon fibre. Mag. 640 diams. Polarized light, system open.

while the photomicrograph (Fig. 6), showing cellulose acetate in cross-section, demonstrates the existence of a smooth edge to the fibre, which, however, is folded inwards at a point on the periphery forming what might be termed a re-entrant longitudinal fold, traversing the length of the fibre. The main point arising from these illustrations is the fact that these two fibres are solid, and, in this respect, are similar to natural silk. All the synthetic fibres are, in fact, solid, which characteristic may prove of value where they will be used as a base material for synthetic laminates or fillers for moulding powders for electrical purposes. By way of interest, the photomicrograph (Fig. 7) shows a nylon fibre of the type used in making high-duty fabrics. In it will be noted what appear to be tiny air pockets dispersed throughout the yarn. These are not bubbles, but particles of a de-lustring agent introduced into the material in order to eliminate the "shine" so characteristic of fabrics woven with a number of these synthetic media. This photomicrograph is included as a means of introducing the suggestion that the possibility of using nylon fabric as a base material might be examined, as it has been the author's contention that electrical insulating materials would benefit greatly if they were based on protein-like materials instead of materials of a cellulose nature. After all, natural silk is an excellent electrical insulator, and, in view of the near protein nature of the nylon, it should compare very favourably with silk, particularly in view of recent developments of electrical grades of these super polyamides.

So much, then, for the basic materials used in the manufacture of laminated phenolics; they are by no means the only materials used, but as they are more widely employed than others, such as woven glass fabric, etc., the finished materials to be dealt with will be those based on natural cellulose in the form of paper and fabric, these latter being the most common.

The examination of phenolic laminates may, perhaps, be best illustrated by a case which the author has examined personally.

It was desired at the time to obtain some type of material in rod form which would be possessed of good electrical properties, and also have as high a mechanical strength as possible. For the type of material envisaged, the particular mechanical strength looked for was strength in torsion, because of the nature of the work to which it was intended to subject the material. The general qualities expected of such a material may be briefly summarized as follows:—(a) Good mechanical strength, particularly in torsion; (b) good electrical properties, as, among other functions, it has to act as an electrical insulator; (c) inherent chemical stability in order to ensure long life in service.

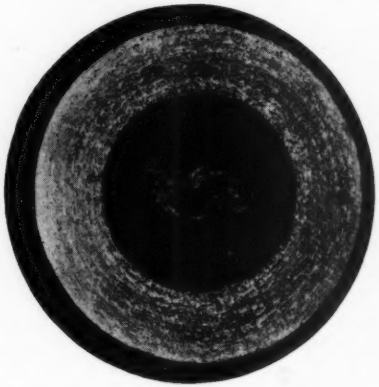


Fig. 8.—Section through rod. Mag. 2½ diams.

It was soon realized that a laminated phenolic of some sort would very nearly satisfy the demands; accordingly in due course samples of a rod material were given to the author for investigation. It was quite apparent from cursory visual examination that the material was a laminate formed by rolling, also the rod appeared to be made up of two different types of materials. It was therefore decided to make a close examination, as a result of which the rod was seen to be

made up of what might be termed three distinct zones. The photomicrograph at Fig. 8 shows a section through the rod in question, magnified to 2½ diameters. When it is realized that the material itself was ⅜-in. diameter, the value of a photograph such as this will be appreciated, for although the magnification is obviously not high, the illustration does give a very good picture of the general structure of the material, as it immediately confirms the original opinion of the rod being fabricated by rolling, and also serves clearly to show the existence of three separate materials making up the whole.

Fig. 9.—Section of phenolic-laminated rod with core pushed out.

It must be appreciated that the photograph, being in black and white, does not do full justice to the original image; in its natural colours, at this magnification, however, the photograph is unsurpassed as a medium for making permanent records of visual images in this type of work.

To return to our subject, however, we see that the material is made up of, firstly, a small " S " shaped core, which, at this stage, appeared to be made up of tightly rolled brown paper, which we may call the primary core. This core would presumably be used as the mandrill on which the next portion of the rod is wound, forming the secondary core, which appears as the dark central disc in the photograph. On this base, consisting of primary and secondary cores, the main body of the rod is wound, this latter appearing light in the photograph. As there appears to be a definite limit to the basic core and the body portion, it is reasonable to say that the core, which is approximately ½ in. in diameter, serves as a stock material which is used as a mandrill for building up larger rods, but the question arises as to why there should be this difference between the core and the body portion. The core itself appeared to be a standard rolled and pressed rod, and, indeed, is so; the body portion, however, did not appear to have been subjected to any great pressure in the curing process, as it was much softer than the core and the paper did not appear to be impregnated with the resin. However, it was decided to leave this question for the time being while the question of the bond between the body portion and the core was examined.

The bond between the two main portions of the rod was tested by facing the ends of a 2-in. length of 1⅛-in. diameter rod and then tapping the core with a piece of steel rod while the specimen stood on end on the open jaws of a vice. The test proved disappointing, as the very first tap pushed the core through the specimen for a distance of about ⅛ in., as shown in Fig. 9, which is a macrograph of the specimen in question at about 1½ diameters. In this specimen the standard core of ½-in. diameter was used, the remainder of the diameter of the rod being made up of the body portion in exactly the same way as the ¾-in. specimen. The cement used for starting the body portion can clearly be seen on the protruding section of the core, the bond between the two portions obviously being inadequate.

The effect of this bond on the strength of the material may well be imagined, and in order to get some definite information on the behaviour of the material under tension and torsion, standard test pieces were turned up and tested on a standard machine.

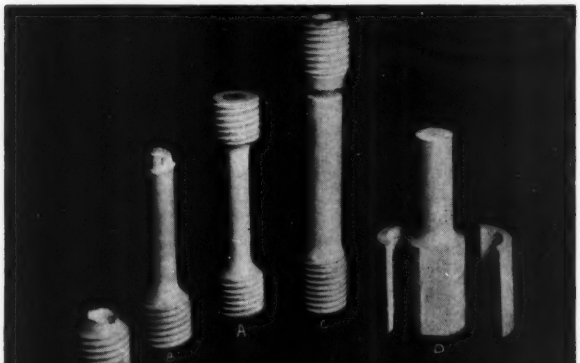


Fig. 10.—Six samples of rod turned for tensile strength tests.

There were six samples for the tensile test, consisting of three each of two sizes, machined from $\frac{7}{8}$-in. diameter rod. Of these six samples the average strength was 2.9 tons/sq. in., and one sample in each group giving no reading, due to the attenuated body portion of the specimen breaking down and the core to body bond giving way. The two specimens in question are shown at A and C, Fig. 10. At A is seen the smaller of the two samples, the crack in the body is clearly seen. The upper portion of the sample could be lifted right off the core, leaving this latter in its entirety attached to the bottom portion of the specimen. This type of fracture is more clearly shown at C, where the two portions of the specimen have been slightly separated to show the intact core. At B is seen one of the group of smaller specimens which appeared to break completely and instantaneously, although the fact that the body portion of the specimen has broken in a different position to the core would tend to suggest that, in reality, the body portion broke first, followed soon after by the core.

In the case of the torsion test, the core would normally have some function, imparting strength to the material, but this would appear to be negligible, as the specimen very soon gave way along the laminæ at the ends where it was gripped in the machine; that portion of the test-piece under examination was untouched. As such, it was, of course, unsatisfactory, but it did show where the weakness of the material lay, i.e., in the body portion again, although in this case the method of fabrication would not appear to lend itself to the development of high torsional strength; the end of one of the torsion test pieces is shown at D, which clearly illustrates the manner in which the fracture occurred, on a line coincident with the keyway cut in the specimen.

(To be continued)

DISTRIBUTION OF INDUSTRY

The Distribution of Industry Act, 1945, comes into operation on June 15, 1945.

The Board of Trade wish to call attention to Section 9 of the Act, which comes into force immediately. With certain exceptions it requires persons who are contemplating the erection of a factory to inform the Board of Trade of their intentions at least 60 days before they let contracts for the erection of the building or begin building operations. No notification is necessary if the proposed building

(1) will have an aggregate floor space of 10,000 sq. ft. or less; or

(2) is required as an extension of an existing industrial undertaking, and is adjacent to another building, used by the undertaking and erected before June 15, 1945.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

PLASTICS COURSES IN STROUD.—The "Stroud News" of June 22, 1945, reports the following:—

The course in plastics which was started at the Stroud and District Technical College in October, 1944, has had a highly successful first season.

The number of applicants for the course exceeded the number that could be effectively dealt with for practical work, and so an early closing date had to be enforced. Students attended from nine firms—six in the Stroud district, two in Gloucester and one in Dursley. All showed great enthusiasm and interest, so that there was a uniform attendance throughout the season.

The education committee of the Institute of Plastics officially approved this college as a centre for instruction in plastics, and the president's fund of the Institute granted £220 to cover expenditure in glass apparatus.

Messrs. T. H. and J. Daniels, Ltd., and the Erinoid, Ltd., have been very helpful in allowing the use of their plant in connection with practical work which required equipment other than that at the college. Messrs. Daniels also very kindly loaned a vacuum pump for practical work on resins and are also lending a press for practical work next session. Messrs. Leicester, Lovell and Co., Ltd., have proved helpful.

Messrs. Bakelite, Ltd., British Industrial Plastics, Ltd., B.X. Plastics, Ltd., Erinoid, Ltd., James Ferguson and Sons, Ltd., F. A. Hughes and Co., Ltd., I.C.I. Plastics, Ltd., New Insulation Co., Ltd., supplied samples of plastics materials. These are placed in an exhibition case in the lecture-room at Lansdown and have proved most helpful to the lecturers and students alike.

Monsanto Chemicals, Ltd., and Synthite, Ltd., supplied samples of chemicals, and the Streetly Manufacturing Co. chromium-plated moulds.

At the recent meeting of the sub-committee appointed to deal with this course, it was decided that, for the 1945-46 session, first and second year courses should be held. At the end of this session, second-year students would be entered for the Technology of Plastics Examination of the City and Guilds of London Institute.

The lecturers for next session will be:—J. H. Collins, B.Sc., A.R.I.C., of Erinoid, Ltd.; H. A. Collinson, A.R.I.C., of Leicester, Lovell and Co., Ltd.; J. L. Daniels, B.Sc., M.I.Mech.E., of Messrs. T. H. and J. Daniels, Ltd.

Both years will meet at the college building, Lansdown, 7-9 p.m., commencing Monday, October 1.

It is important that early application should be made for admittance to this course, for it is proposed to limit the number of students in each year to 25.

"MOULDRITE" ADHESIVES.—The latest of the pamphlets on plastics issued by I.C.I., Ltd., is entitled "Mouldrite" Gap-filling Adhesives. It deals with the properties of U.F. Syrup 232, that is resin content, storage time, viscosity and its uses for the joining of uneven wood or paper surfaces. The adhesives are particularly suitable for aircraft assembly, boatbuilding and in the construction of houses and huts. Excellent data regarding strengths of joint and working instructions are also included.

BRITISH THOMSON-HOUSTON.—Mr. H. Warren has been appointed managing director of the B.T.-H. Co., Ltd. He is 53 years of age, and came from Bristol University to the B.T.-H. Company (in the testing department) in 1911. He was appointed to the engineering staff in 1913. In 1921 he became engineer of insulations, and in 1923 he collaborated with the late Mr. R. C. Clinker in instituting the B.T.-H. research laboratory. In 1929 Mr. Warren became chief of the research laboratory, and in 1938 he was elected to the board of the company as director of research. Recently, Mr. Warren was appointed director of research and engineering, and now, on Mr. H. H. Sporborg's retirement, he becomes managing director.

UNITED EBONITE AND LORIVAL, LTD.—All employees of Lorival Plastics, both works and staff, are to get an extra week's holiday, with pay, in addition to their 1945 summer holiday.

In making this announcement, the Directors and Management of the company,

United Ebonite and Lorival, Ltd., Little Lever, Bolton, conveyed to the workpeople their appreciation of the contribution which all have made to the war effort. Lorival Plastics, like other manufacturers, have been engaged during the past five years entirely on priority work for the Services. Amongst a wide variety of plastic and rubber components which have been supplied for aircraft, electrical equipment, tele-communications and ammunition, can be mentioned plastic grenade parts, telephone-line insulators, battery boxes, and aircraft control pulleys. In size, the products have ranged from battledress buttons to large submarine battery containers standing 3 ft. high and weighing 80 lb.

POLYSTYRENE IN CANADA.—The Canadian Government has completed negotiations with the Dow Chemical Co. of Canada for the erection of a polystyrene plant near Sarnia, Ontario.

MONSANTO CHEMICALS, LTD., advise us that their sales department will again be operating from their London office at Victoria Station House, Victoria Street, S.W.1, commencing Monday, July 9. Orders and communications to this department should be addressed accordingly.

For over five years war conditions have compelled Monsanto to centralize their organization entirely at their Ruabon factory in North Wales, which inevitably has limited opportunities for personal contact with the trade.

It is hoped that with the return to London of those members of the staff who have for many years had the pleasure of close personal contact with their friends in the Trade, opportunities will be afforded for an early re-establishment of those associations.

DU PONT.—E. I. Du Pont de Nemours and Co. has applied to the U.S. War Production Board for permission to make a major expansion of its cellophane plant at Clinto, Iowa. The expansion would take about a year to complete.

Du Pont is planning for a much greater post-war production capacity of this material to meet anticipated transparent packaging needs.

CRYSTALLATE, LTD.—The capital is to be cut to £221,250 by reducing 300,000 8 per cent. cumulative 10s. preference shares to 8s. 6d. and 4,500,000 ordinary 1s. shares to 5d. The 300,000 reduced preference will be converted into £75,000 preference and £52,500 ordinary, both being consolidated into 10s. and 1s. shares respectively.

BRITISH INSULATED CALLENDER'S CABLES, LTD.—This company has acquired the main assets of British Insulated Cables, Ltd., and those of Callender's Cable and Construction Co., Ltd., and will be responsible for their liabilities.

LACRINOID.—Permission to deal, subject to the issue of letters of right, has been given in respect of 300,000 2s. shares of Lacrinoid Products, which the company is to offer next week at 4s. each in the proportion of three for every 10 held.

DR. T. H. DURRANS, F.R.I.C., director of research of Messrs. A. Boake, Roberts and Co., Ltd., has retired. Dr. Durrans has been associated with the company for over 37 years and is well known as the author of "Solvents," the sixth edition of which is now being prepared, and for his work on essential oils. He was chairman of the London Section of the Society of Chemical Industry during 1939-41.

MR. W. G. DAROUX, chemical engineer in charge of plant development at British Resin Products, Ltd., Tonbridge, has been appointed to a new post with Courtaulds, Ltd.

MR. J. B. GRAHAM, M.C., who has been secretary of the Research Association of British Paint, Colour and Varnish Manufacturers since its formation in 1926, has retired from that office and has been succeeded by Dr. S. H. Bell, who has served the Association since November, 1933, in various technical capacities and recently as personal assistant to the director. In addition to his formal secretarial duties, Dr. Bell will be mainly concerned with all development aspects of Research Association activity. As from July 1, 1945, the registered office of the Association has been transferred to the Paint Research Station, Waldegrave Road, Teddington, Middlesex. (Molesey 1063/2202.)

MR. R. SHEPHERD, M.I.Mech.E., who has for the past 13 years been associated with Messrs. Joseph Lucas, Ltd., of Birmingham, as research and development engineer, has now established himself as a consulting engineer to the plastics and allied industries at 21, Broad Oaks Road, Solihull, near Birmingham.

Planned Mould Maintenance Service Aids Economical Production

Part XIV

By W. M. HALLIDAY

The utility of plastic moulded articles is very often greatly enhanced by the judicious application of pre-formed machined insert parts, which may be formed from metals, or other suitable materials. They can be expeditiously moulded directly into position, thus avoiding subsequent difficult or expensive machining operations. Also, in many instances, the plastic part may be considerably strengthened, improved in appearance, lowered in cost, or given special features not otherwise possible.

Inserts are extensively employed in both compression and injection methods of moulding, and in the latter process particularly, extremely ingenious mechanisms can be incorporated in the mould construction itself to facilitate the feeding, locating, holding, and discharging of insert components, so as to function correctly with the timing of moulding cycle.

In all such applications, whether for compression or injection moulding, innumerable problems are raised for both designer and mould maintenance toolmaker to secure sound, foolproof mechanisms capable of operating with the greatest efficiency and the minimum of maintenance requirements.

In this and succeeding sections attention will be given to illustrations of a number of representative kinds of inserts, to observe advantages, etc., and also to the consideration of time-saving feeding, locating and retaining devices and their preferred design and operation features, all worthy of the attention of the maintenance engineer.

MOST plastic mould designers and engineers, and, fortunately, some prospective users, are well acquainted with the very considerable and numerous advantages which can be derived from the application of pre-formed insertion pieces made up from non-plastic substances, and which are capable of being readily moulded into position in the finished article.

Whilst very large numbers of plastic mouldings are made having one or more important metallic or other kind of inserts, as instanced by those required for the electrical industry, users of mouldings generally do not fully appreciate the economies and other advantages which can be gained from the introduction of inserts. Whilst the subject of inserts and insert feeding or securing mechanisms will here be considered mainly from the angle of the mould designer and maintenance engineer, it is hoped that indirectly some benefits and better understanding of the advantages and drawbacks of this important aspect of moulding design, will be vouchsafed to the non-technically minded user or potential user.

Both methods of moulding formation, viz., compression or injection, afford very great convenience for the inclusion during the actual moulding process of such inserts employed to obtain special characteristics not otherwise possible from the plastic material itself. Such inserts need not necessarily be made of metals, but can be of ceramics, other synthetic substances and so on.

Some Reasons for Employing Inserts

Before proceeding to the consideration of the advantages or disadvantages of the various conventional types and designs of insertion parts which are in common usage, guidance may be afforded user and designer alike if a brief statement is made concerning the reasons why inserts are used. Such a statement will clearly indicate the manifold advantages which can be gained by the use of inserts, and thus enable those undertaking the development of a moulding design the better to appreciate the possibilities possessed by the moulded-in insert.

Several aims may lead to the adoption of inserts in a particular design.

The designer may desire to obviate drilling or tapping operations after the

moulded component leaves the mould, or it may be that in the case of very small diameter holes such subsequent machining will not be practicable if made direct into the plastic material. By using a small sleeve, collar or bush, in which the small tapped hole is machined previously to inclusion into the moulding, such difficult operations are eliminated. Brass or steel bushes of a large variety of shape, size and type are normally employed for these purposes.

Sometimes the moulding designer may desire to provide the finished component with a specially shaped hole, such as one bent or awkwardly curved, which would be almost impossible as an economical machining proposition. But by incorporating a length of metallic tubing, previously formed by a simple bending operation to the required shape, and moulding this in position as an insert, his difficulty is very easily overcome.

Or, yet again, the designer may wish to increase the strength of some portion of a plastic-moulded part. This can often be accomplished by using a strip of some suitable metal, and inserting this at the convenient location in mould, there to form an insert at each moulding cycle.

Certain moulded articles are required to possess magnetic properties upon certain portions of their surface, which again is very easily provided for by insert-moulding a piece of magnetized metal.

Another very common requirement is that of obtaining superior bearing and wearing qualities than those usually possessed by the plastic materials, and simple solutions of such difficulties are provided by the inclusion of bearing sleeves or facings in specially suitable anti-friction metals.

Large numbers of special and patented types of fastenings, by means of which a number of plastic-moulded components can be fastened together, are now used as insert pieces and are moulded-in during the compression or injection process, thereby effecting large savings in both materials and labour time, which hitherto had to be expended upon post-moulding operations.

In some plastic-moulding designs metallic inserts are incorporated in order to lessen wear and possible misalignments resulting therefrom, because the moulding forms part of an assembly which has to be repeatedly dismantled and reassembled throughout its working life. Very useful advantages have been secured in this connection, but space forbids the detailing of actual instances, interesting though they are from the designers' and users' points of view.

Large numbers of plastic-moulded components intended for the electrical industry have certain portions arranged to act as good electrical conductors, and generally such characteristics are obtained by including one or more metallic (brass or copper) inserts into the moulded article at the time of its formation.

These, then, are but a few of the reasons leading the user or moulding designer to specify inserts into the finished article, and it should here be placed on record that very often the ingenious moulding engineer and mould designer will be able to overcome apparent obstacles by resorting to this course.

The introduction of insert parts into a mould design very often involves the need for making more or less extensive modification or adaptation to the construction of the tool, and particularly will this be the case in respect of multi-impression tools employed in the injection method of moulding.

In the latter application it will often be possible, convenient and more economical for the designer to provide for a fully automatic feeding of the insert members to the required location within the mould cavity, either by employing a special magazine plate or plates, or some other type of pre-loading and feeding device which operates in correct timing with the cycle of motions of the mould members or machine platens. Then, again, various types of retaining, locating and stripping mechanisms will be called for. Even in the most simple insert arrangements some provision will have to be made for supporting the part prior to injection of the plastic material.

As will be appreciated, all these requirements necessitate some increase in the number of mould members and working parts, whose efficient operation and interaction carries with it the possibility of wear, error or breakage of parts, with consequent interruption of slowing down of production or diminished quality of the finished product. Such possible troubles and operating snags, therefore, entail greater foresight and maintenance attention from the toolmaker charged with servicing the mould. In the illustrations which it is proposed to consider at a later point in this and other articles, typical examples of insert feeding or supporting devices will be shown in order to direct special emphasis upon the probable sources of failure, and how same may be overcome or avoided by the adoption of alternative designs and constructions.

Use of Inserts Tends to Slow Down Production

The introduction of insert parts nearly always tends to retard the speed of production from either compression or injection moulds, for the following reasons:— It is important and desirable that these reasons be fully understood by the intending user of plastic mouldings in order to counter the widely held view that by arranging for a pre-formed component to be moulded in position, one automatically ensures economies. This is not always so, as will be described shortly, because the rate of production is sometimes affected very adversely. In such cases the user must assess all the advantages other than those of economy which are afforded by the use of inserts; usually these on balance show well worth-while benefits in the manner indicated at the beginning of this article.

(1) Usually in cases where the mould is of simple design, form and construction, possessing few cavities, and where the insert parts are of a very simple nature, these are generally applied to the requisite location of the mould during the loading stage by hand. This is done chiefly to conserve simplicity of mould construction and operation, and to reduce toolmaking charges. But it will be realized that such manual introduction of insert and piece will require some little time, because often the operator will have to do some cleaning or manipulation of the part before it can be located correctly. In addition to this, it must be borne in mind that in the case of thermosetting plastics produced by the compression process, the mould blocks themselves will be hot, a feature which will still further interfere with the rapid manual application of the insert.

(2) In some mould constructions, because of the configuration of the cavity area, location of inserts cannot always be secured in the most accessible spots. This may entail the operator some difficulties in quickly and properly placing into correct position the insert piece.

(3) It is also essential that those areas of the mould cavity having to receive the insert shall be maintained scrupulously clean, otherwise wrong location of the member may result, or it may become trapped when the moulds are closed, causing incomplete sealing of the blocks and all connected flashing troubles and so on. Hence for this reason alone the operator will be well advised to proceed with caution when dealing with manually inserted parts of this kind.

(4) Particularly will production time be lost if the mould is not equipped with adequate provisions for the accurate location and safe support of the inserts once these have been placed in position. All supporting pins, studs or spindles should be of very strong construction, especially those employed in compression moulds, as the pressure and drag are likely to be considerable. Nothing will be found more conducive to retarded production and faulty mouldings than loose supporting pins or misaligned studs, etc., on which the insert has to be held during the moulding operation.

(5) In the case of multiple-impression moulds, naturally the time taken for the manual application of a number of inserts is bound to absorb some time between moulding stages. To obviate this, incidentally, the designer endeavours to apply

full or semi-automatic feeding and locating devices.

(6) Again much will depend upon the size, intricacy and accuracy of the insert itself. Where very simple shapes can be used, not much difficulty will be encountered in applying them to the mould area. On the other hand, where it is of an intricate form, entailing several mould members to ensure its correct location and retention, obviously the operator will have to devote closer attention and more time to its application. Similarly in the case of tubular inserts, or those having threaded holes, unless such bores and threaded portions are held to reasonably close limits, the operator may find himself having to juggle about quite a lot in screwing on the insert sleeve to the supporting stud, operations which tend to waste time.

(7) Time is sometimes lost, too, when it comes to the removal of the supporting or retaining pins from the finished moulded part after its injection from the mould. Where threaded sleeves have to be dealt with it will be necessary to unscrew the supporting stud. Various quick-acting devices are employed to facilitate such operations, as will be mentioned later. Suffice it at this point to remark that it is often necessary for the designer to devote comparable attention to the problems of removal of the supporting studs from the moulded-in insert after the component has been removed from the mould. Unless this is done it may be found that an operator is required to devote longer time in such operations than is entailed in locating the insert into the mould area before the moulded article is formed.

Summarizing the foregoing requirements in the form of essential conditions if satisfactory and time-saving operation of the plastic mould is to be secured, the following will be found useful guides for both user and mould designer.

Size Uniformity of Insert Parts

It is important that the diameters and dimensions across sections be held to close tolerances. Limits not greater than plus or minus .001 should be maintained, so that the part will fit into the hole over a supporting pin. Length of insert piece is often less important except in cases where automatic feeding devices are used, in which circumstances permissible errors in part length should not be greater than plus or minus .008.

Externally Screwed Insert Components

Where inserts having a threaded outside diameter are fed to the mould area by means of a gravity feeding device, there will be a tendency for the parts to become jammed by reason of the fouling and partial interlocking of their threaded portions. In such cases provision must be made in the feeding device for the endwise displacement of the part before it is moved axially into the moulding position within the mould.

Safety of Application and Fixture of Inserts

Foolproof provisions must be made to prevent leakage of plastic material due to incorrect location of an insert. All supporting studs or retainers should be amply strong to resist deflection, and be capable of maintaining the part in its proper position throughout the moulding stages.

Preparation of Inserts

Preferably all machined metallic inserts should be degreased thoroughly before applying to the mould, and also all tiny surface burrs, ragged edges, or feather edges of screwed portions removed. Adequate undercut or other keying formations should be provided to ensure maximum grip on the insert in all directions of its possible movement by the plastic material. Sound mechanical anchorage of the insert is essential.

Removal of Locating Studs After Ejection

The shape of insert and its supporting or locking pin within the mould cavity must be such as will permit rapid and simple extraction after the moulded article is completed.

Essential Requirements of the Moulded-in Insert

Coupled with the above requirements necessary to secure the maximum production outputs where mould inclusions are employed, it will be useful to summarize also a number of other general features associated with the design and formation of insert parts, which features may be considered the basis of sound insert design.

These features are:—

(a) The insert should be sufficiently robust to withstand the heavy compressive and tensile stresses imposed upon it at the time of moulding and with the normal shrinkage of the plastic material. This will apply especially to thin-walled tubular or long, slender articles which are liable to collapse or deflect.

(b) Where long insert pieces have to be used it will be found preferable to make these in good-grade brass because the coefficient of expansion and contraction of this material is the closest to that possessed by the average plastic material. In this way undue stresses and possible cracking are reduced, especially where the finished part has to operate in circumstances of varying temperature.

(c) Wherever possible all inserts should have those portions normally protruding into the moulding made cylindrical in shape for this reason. This portion of the insert usually has to be housed in a hole produced in the mould block, and as cylindrical ones are the most easily machined, this form should be stipulated in preference to all other shapes.

(d) Sliding or rotating members of the mould set should not be used for housing or locating insert members. They should, as far as ever possible, be located in stationary, solid, and substantially dimensioned portions of the main blocks.

(e) Various measures are adopted to prevent inserts from moving when once moulded in position. Thus the part may be provided with an exterior knurled surface, or one having irregularities, slots, or undercuts. Holes and grooves across the top of the part are also good ways in which keying is secured.

(f) It is generally highly desirable that in locating the position of inserts selection be made of points which bring them into proper relationship with the mould block parting line. Thus the axis of the portion of insert extending into the mould block shall be exactly at right angles to the parting-line surface, otherwise difficulty will be occasioned when the moulding is to be removed.

(g) Very often it is found advisable to use the inserted bush or part for ejection purposes by locating the ejector pins or sleeves so that they act upon the end of the insert. In this way savings can be made whilst the operation of ejection is attended with less risk of distortion to the finished part and disfigurement of its surface.

(h) Another general factor which deserves careful attention relates to the methods usually adopted for retaining sleeve-type inserts upon their supporting studs during and prior to actual moulding. Springs should be used as sparingly as possible because of their great unreliability and proclivity to fatigue and fracture when least expected. Very often tension or compression springs are used in connection with the holding studs, and, later, illustrations will be given of various common types of such pins in order to indicate their general unsatisfactoriness.

(i) Where the insert piece has to project both into the machine ram or punch and the mould cavity it will sometimes be difficult to prevent the plastic material from being squeezed up the sides of the hole in the ram. This will produce unsatisfactory and stiffened working of the mould and perhaps misalignment of the insert piece.

(j) In respect of the amount of projection of an insert within the mould cavity a reliable rule for use in connection with compression-moulded components is that such projecting portion should not exceed two or three times its diameter at that point.

In the case of injection moulding this ratio of length to diameter may be increased up to three to four times the

diameter, or even greater than this, provided that the diameter of the insert is substantial.

(k) Care should always be taken when arranging for an insert to be moulded in place that flash is not caused, or that flow of plastic material takes undesirable directions. Thus, threaded inserts, whether internal or external, must be so arranged to prevent the plastic from flowing up the threaded portions, which would cause difficulties when removing the supporting stud or in engaging the screwed component required to match up with the insert.

Insert Support Pins for Compression Moulding

Doubtless it will be appreciated from the foregoing discussion that many operating troubles of moulds incorporating insertions arise not so much from the actual insert part itself, but rather from the means provided for its support and location within the mould cavity.

Such troubles will be specially present in the case of compression moulding, where the pressure on all portions of the mould cavity area is very great. Any projecting pieces are similarly subjected to the same pressures, and frictional drag set up by the flowing plastic material. Therefore it is highly desirable that long, slender or weak supporting pins be rigorously avoided.

It is scarcely necessary to dwell at any length upon the delays, worry, and maintenance costs involved in the use of such undesirable members. It is often not so much the actual breakage of a single support pin which is the cause of the main worry for the maintenance toolmaker as the associated snags and breakages following an operator's failure to notice such a fault in its initial stages.

Thus it may often be found that a weak support pin has become distorted. Continued use in operation causes it to become badly misaligned with other parts of the mould, a feature which gradually worsens, until it fails to match up at all with these other parts. The result is either a bad jamming and breakage of several parts, or the mould blocks cannot close properly, or the supporting pins become so violently out of line that the ejector mechanism of the mould cannot function, or else is damaged in efforts made to operate this portion of mould.

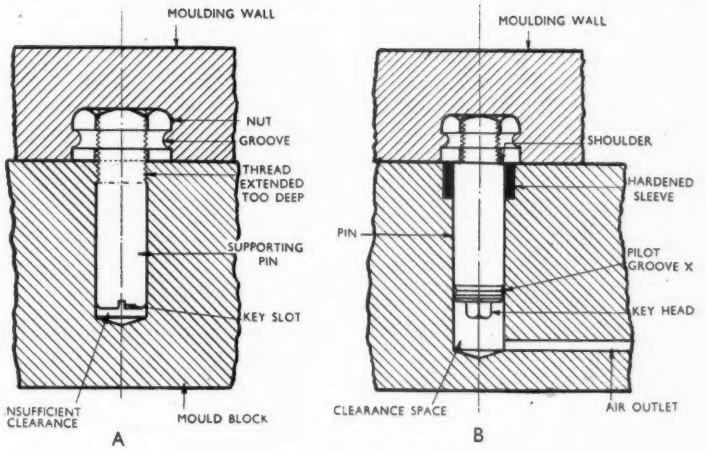
Another fruitful and common set of troubles consists of shorn-off supporting or retaining studs. If these are unnoticed, very great damage may be done to the mould cavity surface when next the mould blocks are closed.

Yet another point well worth bearing in mind in connection with support or locking studs, etc., needed for securing insertion sleeves and the like is that of material expansion. It must be remembered that the compression mould is usually worked at fairly high temperature, and ejection of the finished product has to be made whilst the mould is hot. If the supporting pins, in particular (although this will apply to the insert material also), expand at a greater rate than the material of the mould blocks they may bind so much within their locating holes in the latter as to give rise to several snags during ejection of the part. Due allowance must be made in the degree of fit between the pin and its hole in the block, when cold, to allow for any unequal rates of expansion.

Methods and Provisions for Locating Inserts Within Block

Having now dealt at some considerable length with a number of important general features relating to insert design, construction and application as required by the compression type of production, we come now to an examination of various common types of support and locating pins and methods of fixture to the mould block.

It will be observed that in all the ensuing illustrations are not only good and undesirable forms of insert considered in order to discover their practical merits, etc., but also it will be specially noted that preferred and unsatisfactory methods and designs of supporting or locating pins are illustrated and commented upon so



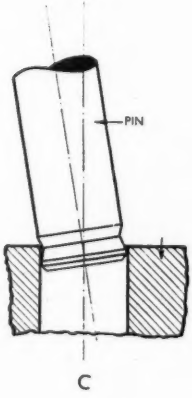


Fig. 1.

that some indication is afforded of the general lines upon which the designer should follow in both respects.

It is proposed to deal first with a very common type of insert, which has already been mentioned, and one which is in very extensive use. This comprises a hollow sleeve, bush or nut, possessing a threaded bore. Its use is to eliminate tapping operations after moulding.

Referring, then, to the illustrations shown in Fig. 1, it will be seen that the insertion component in each case (see sketches A and B) consists of an ordinary standard-type brass or steel hexagonal nut. As here shown, this nut is positioned from the bottom block and held in such a manner as to project into cavity area. They are the most conveniently located in this way, but they can be used in suitable conditions in the top block, but in this case a specially designed supporting pin will be necessary, as will be dealt with later.

The nut itself is machined with a groove around its exterior as shown, into which the plastic material can eventually reside, thereby preventing endwise movement of the insert. Turning motion is prevented by the hexagon shape of the nut itself.

This insert nut is supported and secured by means of a specially designed pin here shown. This pin has a plain cylindrical shank made a close sliding fit within the plain hole machined in the bottom block and located at right angles to the parting-line surface of the block. The upper end of the pin is provided with a threaded portion made to screw easily into the tapped hole on the nut insert.

It will be apparent that before the mould blocks are closed for the moulding cycle, it will be necessary for the operator to screw on the nut insert to the projecting threaded end of this supporting pin, which, of course, is withdrawn from its

housing hole for this purpose. The nut and support pin are then replaced with the bottom face of the nut resting upon the parting-line surface of block as shown.

After the plastic moulding has been cured, the blocks are opened and the finished part ejected in normal manner, bringing with it the support pin, which latter has then to be unscrewed, a small slot being provided for this on end of pin.

The design of support pin shown at A in Fig. 1 possesses several important disadvantages.

Thus, in the first place, it will be observed that the threaded portion and plain end of the support pin are the same diameter, and that the threads extend well down into the housing hole in mould block. This will mean in practice that fine slivers of plastic material may be squeezed down between the threads and sides of the hole in block at each compression stroke. Should this occur, there will be a distinct danger of tightening the sliding action of the support pin within the block and likely to occasion troubles when the finished part is ejected.

A second possible source of trouble lies in respect to the means provided for unscrewing the pin from the finished moulding. At the bottom end of the pin a cross slot is machined in which an ordinary screwdriver may be affixed. This slot will tend to get bruised over from constant usage, especially at its sides, with the result that the pin itself may become stiffly fitting within the hole in block.

This has been known to cause a complete seizure of a supporting pin, due, of course, to neglect in the early stages of burr formation.

A third unsatisfactory feature to be noted is that there is an insufficient amount of clearance between the bottom of pin and end of hole in block. This is likely to lead to several troubles. However conscientious the operator may be in keeping the mould clean, some dirt will be bound to accumulate in course of time at the bottom of holes such as these, with the result that they will speedily cause a choking up of the restricted clearance, and the consequent difficulty in correctly positioning the supporting pin.

Allied to this disadvantage is that of the lack of means for escape of trapped air from the small space left at bottom of hole when the support pin is in position. It will be understood that this is an important point when it is remembered that these pins must be a smooth, close sliding fit in order to ensure effective sealage against plastic material. In such circumstances there is little opportunity for air to find escape up sides of hole and pin. The author has encountered numerous instances where is has been found difficult to secure repeatedly correct location of an insert and its supporting pin due to the action of trapped air, tending to lift the pin upwards from its true position.

At sketch B to the right in Fig 1, a very much improved form of locating and supporting pin arrangement is shown. Here, again, the insert comprises an ordinary hexagonal nut grooved in the same manner as that at A. The locating pin is reduced in diameter a substantial amount at its upper end, this portion then being threaded to suit the tapped hole in the nut-insert. The advantage of this feature is that a square shoulder or stepped portion is provided against which the nut-insert can be firmly screwed. Not only is the insert piece thus more reliably positioned, but the risk of flowing plastic material finding ingress to the housing hole of pin in the block is very considerably lessened. To all intents this design imparts a complete seal-off against flash formation along the threads.

It will also be specially noted that the plain hole in the mould block is machined very deep so as to leave an ample clearance space beyond end of the supporting pin. A small-diametered drilled hole extends from this clearance space to the outside of the mould block in order to allow any trapped air easy escape.

The bottom end of the supporting pin is also machined either square or hexagonal as desired on a slightly smaller extended portion so that a standard type key or spanner may be used to rotate the

Any Tint or Colour

TO SUIT YOUR INDIVIDUAL NEEDS

'Cellastine' Moulding Powders are suitable for both injection and compression moulding. They are remarkable for mechanical strength, toughness and wear resistance. Stability of colour is another valuable distinguishing feature.

The wide knowledge of our Technical Advisory Staff has been gained through many years of research and practical experience covering an extensive field of application. Their services are at your request for consultation and development.

'CELLASTINE'

TRADE MARK

Moulding Powder

Sole Manufacturers of 'Cellastine' Moulding Powders and proprietors of the Trade Mark 'Cellastine'
BRITISH CELANESE LIMITED, CELANESE HOUSE, HANOVER SQ., LONDON, W.1

D.18

READY....AYE READY!

What a fine fumbling job it is, messing around with dozens of tiny nuts and washers and bolts, picking up the nut, holding the bolt with one hand while the other fiddles round the back to get the nut on the thread. And drops it! You know! Spire solves the problem. Spire U Nuts slip into position over the bolt holes — no washers needed with a Spire fixing, of course. So both hands are free to put in the screws and once they're in, they're in for good. Sounds easy and it *is* easy!

THAT'S Fixed THAT! Here's a little chap in action Reference No. NU 531. Its uses are legion. Wherever there is blind assembly work, wherever your operatives are fumbling with nuts and washers the NU 531 will save time and cost and a lot of bad temper. Clip it into position and it stays "put" until you are ready to drive home the screw. No washer needed of course.

Spire

***A BETTER way of fixing**

Simmonds Aerocessories Limited • Great West Road • London • A Company of the Simmonds Group

pin when unscrewing from finished moulded article. If desired, this portion may be made tapered so as to fit the special driving chuck attached to the spindle of the portable electric drilling machine. In this manner rapid extraction of the pin can be effected. The chief feature to notice in connection with this extractor key extension on end of the pin is that it should be made considerably smaller than the plain diameter thereof which fits in the hole in the block. This is advisable because any burrs, etc., which may eventually be formed on the extension will not cause the pin to become tightened within its hole, as in the case of the type of pin described and shown at A.

Yet another decided improvement to be observed lies in the provision of a small, hardened, renewable liner sleeve situated at the mouth of the hole in block. It will be found that there is a strong tendency for the guide holes in the mould block to wear bell-mouthed as a result of continual insertion and extraction of the supporting pins. If this feature occurs it is often difficult to ensure correct alignment of the pin, or to obviate flash over of plastic material into the space worn by the bell-mouthing of hole.

Such a replacement ring can be very quickly and inexpensively replaced without causing loss of time should wear develop. In fact, the far-seeing mould maintenance engineer will be able to maintain a small stock of such hardened sleeves in readiness.

A further very useful and time-saving feature which the writer recommends concerns the provision of a special aligning groove around the lower end of the plain portion of the guide pin, as shown at X. In shape, purpose and results this groove is identical almost with that of the well-known "Pilot"-type groove introduced for, and used in conjunction with, ordinary plug gauges to obviate jamming. At C to extreme right hand in Fig. 1 is shown an enlarged illustration of this groove, which indicates its non-jamming facilities.

By this groove it is impossible for an operator to get the supporting pin crossed at the mouth of the hole, and so waste time in inserting it in position. In the case, say, of a multiple impression tool where a number of such close-fitting support pins have to be located, the time saved by this provision will be great.

All such type supporting pins should, of course, be hardened and ground on their plain portions and, where possible, means provided for applying lubricant. In the case of the design shown at B, oil is inserted down the air escape hole when the supporting pin is removed from the hole.

Before leaving this type of insert it remains to point out how essential it is that there be no burrs or raised edges on the flat face of the nut insert, which has to bear against the shoulder of the support pin and parting-line surface of the mould block. If the nut cannot sit down snugly on to these faces by reason of dirt or bruises, etc., plastic material will be forced into the interstice, which flash will have to be severed before the finished article can be ejected from the mould cavity.

The end face of the threaded portion of the supporting pin should also be made just long enough to come flush with the upper end face of the nut insert.

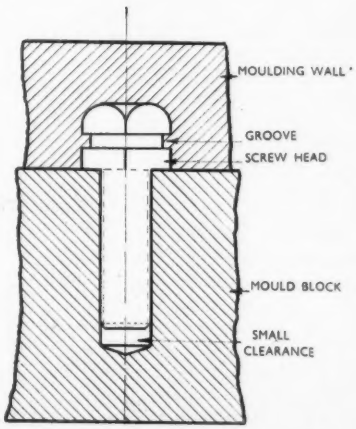


Fig. 2.

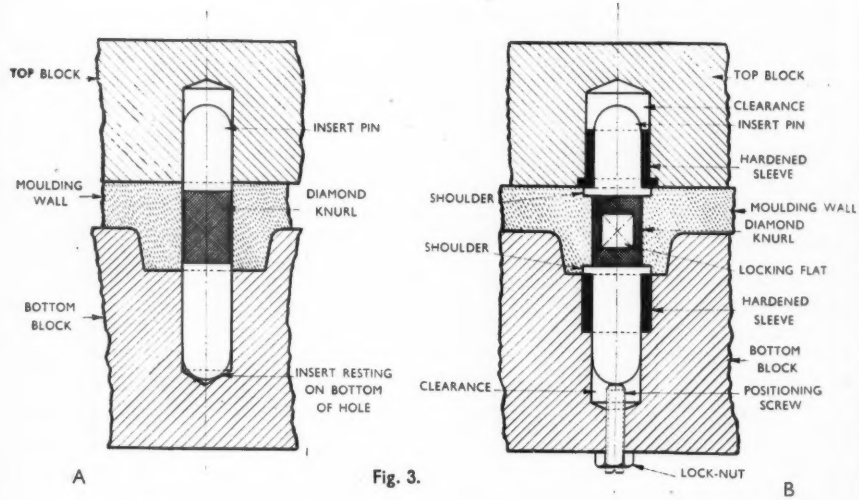


Fig. 3.

In Fig. 2 is shown yet another interesting and very simple type of insert often employed. This consists of an ordinary-headed screw, either square or hexagon, which head portion is provided with a groove, as indicated. The threaded shank is inserted into a guide hole provided in the mould block.

Whilst this type of insert is extremely inexpensive, in that no supporting pin, etc., is required, there are several possible disadvantages to guard against in the following ways:—

First of all, it will be very hard to ensure that all screw inserts are free from burrs or turned-over sharp edges at the bottom surface of their heads. The presence of such burrs will cause the head of screw to be lifted slightly clear of the parting-line surface of block, and the forcing in of plastic material. This may then find a way down the threads, and so cause the screw to become jammed within the hole in block.

Then again, care will have to be taken when applying such insert screws to their guide holes, lest too forcible application turns over the leading edges of the threads. Especially will this danger be present if the screws are of soft brass, aluminium, etc., materials which easily bruise when in sharp contact with steel.

A further possible trouble lies in regard to the outside diameter of the threaded shank of the screw. As most machinists are aware, it is far more difficult to maintain the outside diameter of a screwed component within close limits of error than in the case of a plain piece. So that usually some little troubles are experienced in respect of the fit between the threaded shank and its hole. Where possible, the screw shank should not be threaded right up to the underside of head; instead a short length of plain portion could be left, which will then assist towards securing a better fit throughout the run of a batch, and also ensure more effective seal-off of plastic material.

At A in Fig. 3 yet another useful and common type of insert piece is illustrated. This consists of a cylindrical pin which has to be fastened to the wall of a plastic moulding in such a manner as to permit a projecting portion each side thereof as indicated. Simple as this type of insert design may appear, it is one which may be fraught with considerable operating snag, entailing frequent attention from the maintenance engineer.

This insert is actually a plain pin rounded over at each end and coarsely

diamond knurled on its middle portion around which the plastic material is moulded so as to secure the pin in position. The insert-pin is located in the guide hole at right angles to the parting-line surface of the bottom block as shown. The upper portion has to pass into a guide hole in the upper or top mould block, in which hole it has to be a close sliding fit as in the case of the bottom hole. The pin rests upon the bottom of the hole in bottom block.

Several drawbacks will at once be apparent from a consideration of this design in the light of the previous examples.

Thus, in the first regard, the method of locating the vertical position of the insert-pin is very unsatisfactory, and in order to ensure continued accuracy in this respect will entail very frequent stoppage of production so as to clean out the bottom of the hole in lower block and thereby permit the pin to reach its correct position.

Secondly, should the sides of the hole in bottom block eventually wear, allowing the insert-pin to stand slightly out of vertical line, some difficulties in respect of the alignment of pin and hole in top tool will be experienced.

Thirdly, unless the diameter of the knurled portion of the insert-pin were to be fairly large, or the knurling cut exceptionally deep, there would be some risk of the pin shifting endwise as well as turning.

A very much improved design of insert-pin and method of locating same in position is shown at B in Fig. 3.

Here it will be seen that the insert pin is provided with two shoulders made slightly larger in outside diameter than the shank and central portions. Between these two shoulders the material is coarsely knurled as before, and two flats machined diametrically opposite on the pin still further to assist locking.

Both the guide hole in top block and that in bottom one are lined out with hardened steel sleeves. These members are provided with a small shoulder or head let into a shallow recess cut into parting-line surface surrounding the mouth of hole in each case. The diameter of the head of each sleeve is made considerably larger than that of the shoulders on middle portion of the insert-pin. This provision ensures an effective seal-off of material, thereby preventing flash formation at this point.

Vertical positioning of the insert-pin is secured by means of a small adjusting screw passing through a tapped hole in bottom block and extending right into the guide hole itself as illustrated. A small lock-nut on the exterior of the mould block serves to retain this positioning screw in its correct setting. The contact end of this positioning screw should preferably be case-hardened.

One great advantage in the case of this design is that it is possible to make the portions of the insert pin which have to engage with top and bottom blocks respectively a slightly slacker fit in these holes than normally, because the shoulder portions do provide for an effective seal-off of plastic flow. Thus, if there is slight misalignment of the insert, or should one be encountered bent along its length, no untoward locating difficulties would arise, such as would certainly occur in the plain parallel unshouldered type of insert described at A in Fig. 3.

Coming now to Fig. 4, this illustrates a useful design of supporting pin for use in conjunction with a sleeve-like insert having a tapped hole which has to be left

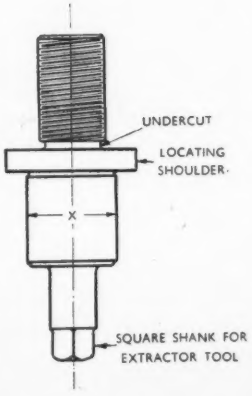


Fig. 4.

clear of plastic material. The upper portion of this pin is threaded to suit the tapped bore of the insert piece, which latter member is not shown. A suitable undercut is left at the bottom of the threads so that the sleeve insert piece may be screwed right down to the enlarged shoulder without difficulty.

The pin is situated and located within the hole in the mould block by the plain parallel portion whose diameter is X, and a notable feature is that of the large circular flange at the junction of the threaded and plain portions. This flange is let into a suitable recess in the mould block.

At the lower end of the pin is an extended piece of smaller diameter having a squared end for fitting to an extractor tool or spanner.

This form of support pin will be infinitely more satisfactory than the straight types previously mentioned and discussed in earlier examples. Its advantages are easily observed, and are as follow:—

It is very easy to manufacture, extremely handy and rapid to locate in its guiding hole, especially if the non-jamming type of groove already described is formed on the leading end of the seating portion. Removal of the pin is also easily performed. By reason of the large shank diameter fitted into the mould block, and also the large shoulder, it is capable of withstanding very high deflecting pressures. It should preferably be case-hardened and ground and used in conjunction with a hardened liner in the mouth of guide hole in a bottom block. It will be realized that it is unsuitable for use in the top block because of the lack of means for holding it in position during moulding.

In Fig. 5 two forms of what is known as the valve-head type of supporting pin are shown. It is a kind which possesses several useful advantages, such as great strength, being specially effective in the case of large-diametered pins; and considerable degree of resistance to shearing or compressive loads.

On the other hand, this type of pin has been known to move slightly out of position under the flowing action of the material, and it is usually difficult to reproduce, particularly on its tapered portions. In addition, an exactly mating tapered socket must be machined on the mould block and an accurate angular seating must be ensured if the pin is to be correctly located.

Furthermore, the pin will require forcible extraction and cannot be pulled out simply by the operator's hand, as is the case with a pin having a parallel shank.

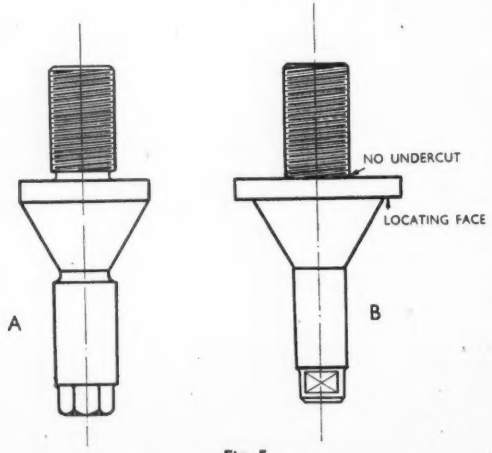
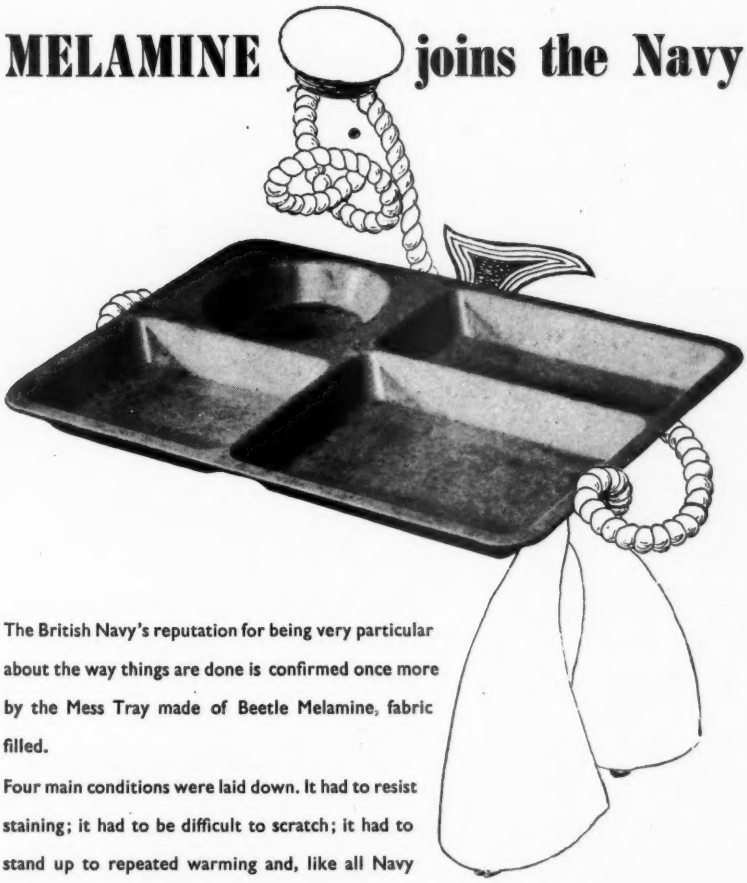


Fig. 5.

The style shown at A in Fig. 5 is not so good in actual practice as that shown at B. The reason for this is that the tapered portion is not crowned with a flat shoulder as at B. This means that when the pin is in position and moulding pressures are imposed upon it, the tapered head will be very powerfully driven into its tapered socket, causing considerable troubles sometimes when the stage is reached for extracting the pin with the moulding.

To avoid such troubles an improved form of pin is sometimes used, shaped as

MELAMINE joins the Navy



The British Navy's reputation for being very particular about the way things are done is confirmed once more by the Mess Tray made of Beetle Melamine, fabric filled.

Four main conditions were laid down. It had to resist staining; it had to be difficult to scratch; it had to stand up to repeated warming and, like all Navy equipment, it must be able to take a knock.

These mouldings of Beetle Melamine are harder, tougher, and more resistant to staining, and they withstand higher temperatures. During the war all Melamine mouldstuffs go for Service purposes; their advantages for certain post-war purposes are assured.

B·I·P GROUP

BEETLE PRODUCTS CO. LTD

1 ARGYLL STREET, LONDON, W.1.

FROM FINE FINISHES

The well-known CELLON range of products has been built up largely by the rapidity with which the CELLON technicians appreciate the importance of new innovations and new industries.

The rapid increase in the use of Plastics presents intricate but surmountable problems and, in fact, CELLON Synthetic Finishes and Thermo-Plastic Adhesives have already been devised and are in use for numerous special purposes.

CONSULT CELLON on all problems of finishing or jointing materials, and let them give you the benefit of their experience in this and other fields. The address is Richmond Road, Kingston-on-Thames, Surrey. Telephone: Kingston 1234 (5 lines).

TO FINE ADHESIVES

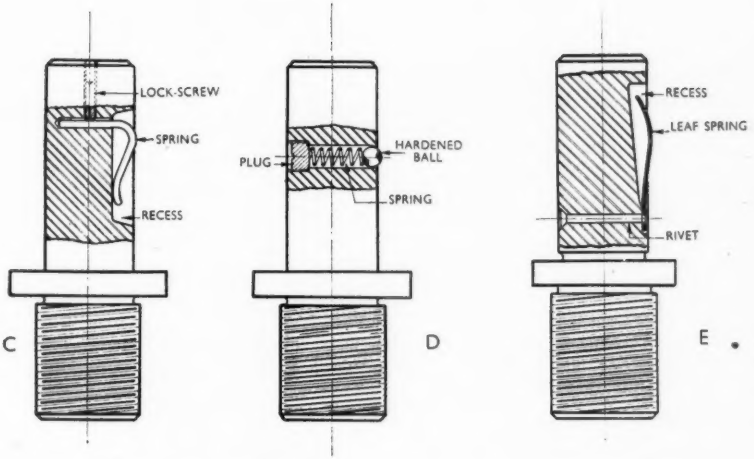
CELLON

A Cellon product

The final word in finishes...

CELLON
CERRIC CERRUX

CVS-531



shown at B, the chief purpose of the cylindrical shoulder being to prevent the pin from being unduly jammed into its seating. The only difficulty in connection with this provision is that the seating taper and taper portion of the pin itself must be very carefully machined so as to bring the locating face on underside of the shoulder just in contact with the parting-line surface of mould block when the tapered surfaces are contacting.

Next we come to the consideration of plain supporting pins intended for use with inserts having plain bores instead of threaded ones. Another advantage of such type of pin is that it can be used in the top block or punch tool and will hold and support the insert sleeve, etc., in its proper position whilst blocks are being closed and plastic material injected or cured. Usually this latter facility is obtained by recourse to springs of one kind or another, and at C, D and E in Fig. 6 are shown three different but very commonly used types.

Dealing first with the design shown at C, it will be noticed this comprises a plain shouldered pin, having its lower end threaded so as to be a screwed fit within the mould block, in which, by the way, it can be allowed to remain, there being no necessity to remove the pin with each

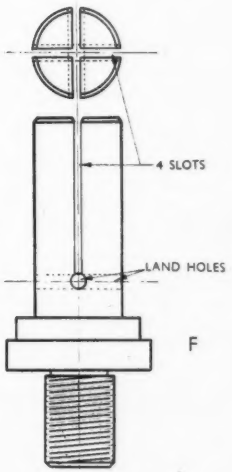


Fig. 6.

completed moulding, since the latter will simply slide off the plain end of pin. The holding means for the bush insert, etc., consists of a piece of spring wire bent over to the shape illustrated and secured in a blind cross-drilled hole by a small screw passed into a tapped hole drilled down centre of pin from its top end. The side of the supporting pin is recessed out slightly and for a sufficient width to allow

the rounded portion of spring to seat therein. When the pin is without the sleeve-insert member the spring extends slightly above the exterior of pin as indicated. When the insert part is passed on to the supporting pin the spring is depressed into its recess a small distance, thereby imposing a sufficient frictional pressure upon the inside wall of insert sleeve adequate to retain it in its place.

At D is illustrated another very widely used construction which is slightly better than the first kind in that very easy and simple means for increasing the spring pressure is provided, so that large and heavier insert sleeves and suchlike parts can be gripped effectively, whereas, with the type described at C, a new spring would probably be required.

With design D a spring-loaded hardened steel ball is located in a cross-drilled hole in the plain portion of support pin. This hole is drilled in such a manner that the ball cannot pass completely out. The small compression spring is held in place against the ball by the fixed screwed plug member threaded into a slightly larger tapped portion of the hole as shown.

By adjusting the position of the screwed plug, varying degrees of compression can be imposed on the ball, and so greater or a reduced gripping pressure obtained upon the insert member housed on the pin. In the case of very heavy inserts, two or more such spring-loaded ball arrangements could easily be employed on the same pin in order to secure sufficient holding pressure to prevent the insert sleeve from falling off the vertical pin.

The third spring-type supporting pin for vertical top tool locations is shown at E in Fig. 6. This type has the merit of very simple design and consists only of a flat leaf spring member riveted securely at its lower end to the shank of the supporting pin. This latter is machined firstly with a recess whose bottom face is tapered or inclined in the manner illustrated. The leaf spring itself is so arranged as to exert adequate pressure upon the bore of a sleeve insert for holding the latter in its proper position.

Whilst all these three common designs have the advantage of simple construction and cheap manufacture, ensuring also easy insertion of the sleeve insert, and similar free removal after the moulded article has been made, there are certain drawbacks which it is advisable to mention. They all rely upon spring action to retain the part in position, and, because of this, are all prone to fail due to fatiguing or breakage of such springs. As has been mentioned much earlier in this series of articles, the tension of a spring when used in connection with compression moulds, especially where the working temperature is high, may suffer speedy and considerable variations.

In the case of the ball-type pin as at D, it may be found that the action and movement of the ball with the hole in pin is restricted by the accumulation of dirt, burnt oil, excess plastic material, powder and so on. This will mean frequent removal of the plug, spring and ball to clean out the hole and check up on the springiness of the spring.

With respect to the leaf spring type shown at E, one trouble likely to occur is that the spring will tend to weaken or ultimately crack across the centre of the rivet pin hole. Or the heat of the mould may cause the rivet to expand and loosen the leaf spring.

To avoid such snags and others which might be mentioned, it will be necessary for the maintenance toolmaker to devote careful and frequent attention to the condition of the springs, cleanliness, etc.

A fourth type of spring supporting pin is shown at F in Fig. 6, and this is to be preferred before all the other types, although it requires rather more trouble in its manufacture. This does not rely upon external springs, but rather upon the natural springiness of the pin material after it has been slotted along its length in the manner illustrated.

Four long and narrow slots are machined into the plain portion of pin upon which the sleeve insert has to locate, these being formed by passing a thin slitting saw or milling cutter clean through the part in two directions 90 degrees

ABOVE SUSPICION

The story goes that Julius Cæsar divorced his wife, not because she had actually 'done wrong' but because there were rumours. Hard luck (perhaps!) on Pompeia.

The tools and jigs, the gauges and moulds of modern production must be like Cæsar's wife — above suspicion. Else in a thousand, a million products, the tiniest flaw, the smallest error will be multiplied and manifest.

'Right from the Start'

ALLTOOLS LIMITED

125 HARLEQUIN AVENUE, GREAT WEST ROAD
BRENTFORD, MIDDLESEX. TEL.: EALING 6464

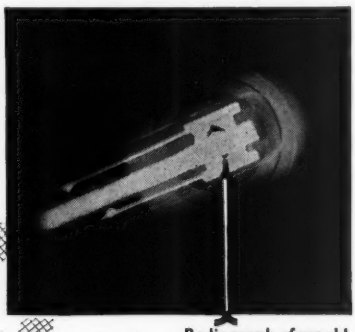
C.R.C.5

X-RAY INSPECTION EQUIPMENT FOR THE PLASTICS INDUSTRY

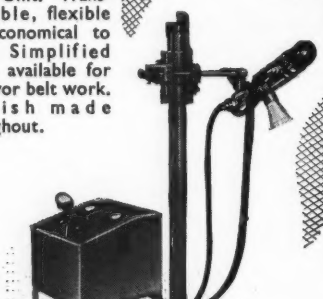
SIMPLE · SAFE · ECONOMICAL

Non-destructive testing by X-rays is as modern as the science of plastics itself. As a simple routine measure it has solved the inspection problems of an increasing number of industries. Viewing under X-rays leaves nothing to chance. Defects which would otherwise be hidden are quickly and clearly revealed. To meet the vital needs of today quality control by the X-ray method is something to be investigated. Write today for particulars of the "MACRO 100" industrial X-ray unit and its application to the examination of plastic mouldings and assemblies.

★ **QUICK DELIVERY**



Radiograph of moulded assembly showing incorrect location of metal insert.



PHILIPS "MACRO 100" Industrial X-Ray Unit. Transportable, flexible and economical to run. Simplified model available for conveyor belt work. British made throughout.

PHILIPS METALIX

PHILIPS LAMPS LTD.

CENTURY HOUSE, SHAFTESBURY AVENUE

LONDON, W.C.2.

Telephone . . . . . Gerrard 7777

apart. The upper end view shows the final result. Land holes are first provided through the shank of pin near its shoulder into which the slots extend. This type of pin should be made from tool steel and hardened and ground. Before hardening, the slotted portions should be lightly expanded a slight amount, so that, finally, the diameter of these expanded portions is somewhat larger than the bore of the sleeve insert. When this latter is passed on to the expanded pin, a light force will be necessary to close the parts inwards, they afterwards sufficing to hold the sleeve in its proper place.

Another design, and one which, again, does not depend upon spring action at all, and therefore is more to be preferred than the previous types, is shown at Fig. 7.

In form the supporting pin follows very much the same shape as in previous instances, except that its upper end is extended so as to project beyond the end of the insert sleeve, etc. This end portion is then slotted in such a manner as to form a squared shoulder immediately underneath the circular head portion.

Made so as to be a sliding fit within this slot is the specially shaped detachable washer shown at the right hand. This C-shaped washer has an opening able to pass smartly over the squared shoulder on pin as shown.

Whilst this construction is extremely simple in use, yet effective, and very inexpensive to manufacture, its application is somewhat limited to the kind of insertion pieces which can be housed within a recess within the lower block, in which case the slotted washer, etc., normally extending over the end of the insert can be housed within the recess and thus screened from coverage with plastic material.

One final word remains to be said about these various designs of supporting pins, and that refers to methods used for ejecting the finished moulding. Usually, the part having a plain hole can be withdrawn easily, the mere opening of the blocks sufficing to draw the insert, now moulded-in, off its fixed supporting pin.

But where the insert sleeve, etc., is screwed on to the threaded supporting pin, the moulding engineer will have to find some very rapid yet efficient method of unscrewing the pins from the finished mouldings, whilst they are still in the mould cavity of the movable block, and afterwards an equally rapid method of rescrewing-in the pins into the mould block in readiness for the next cycle.

This is often facilitated by first knurling a short length of the supporting pin on its shoulder periphery where possible. If this is not convenient, it will be necessary to reduce a short portion of the shank for this purpose. The tool required for removing the pins then consists of a short wooden stick having one side faced

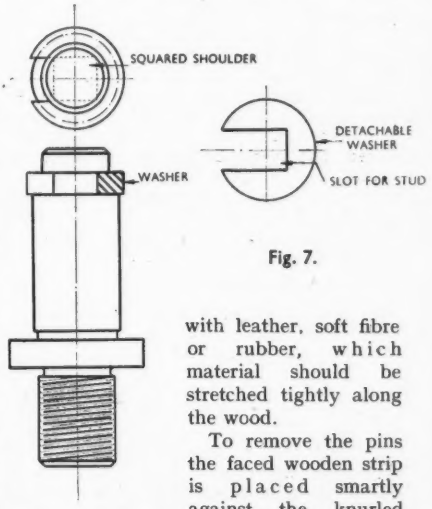


Fig. 7.

with leather, soft fibre or rubber, which material should be stretched tightly along the wood.

To remove the pins the faced wooden strip is placed smartly against the knurled side of pin and a swift forward motion imparted to stick, the frictional contact between the leather facing and the knurled exterior of pin shoulder will then cause the pin to be rotated very swiftly with sufficient force to unwind the pin from the tapped hole in the moulded-in insert. After a little practice with this method it will be found that an operator gains extreme dexterity at removing the pins, thereby saving much time and effort.

The author is acutely aware that the

illustrations here given and described constitute only a few of the many equally simple designs of supporting pins used in connection with hollow-threaded and plain inserts, but detailed consideration of all such designs would be impossible with the space available. It is hoped that sufficiently interesting and well representative types have been selected for discussion and illustration as will afford useful guidance to the potential user and mould designer, but most especially to the mould maintenance engineer, who will thereby be better enabled to assess the practical working merits of any particular construction.

In the next section rather more complicated forms of inserts and insert-loading or locating devices will be dealt with. Simple pre-loading mechanisms, magazine feeders, of both a semi- and full-automatic nature will be illustrated.

THE TURNER UPSTROKE PRESS

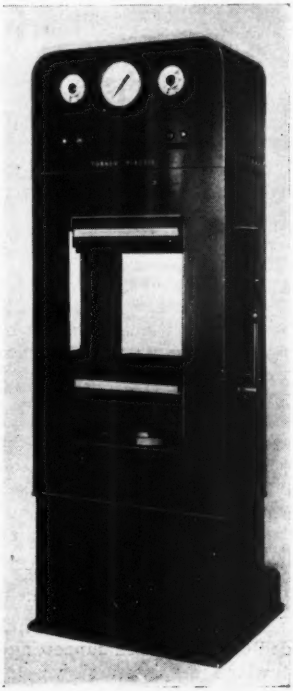
THE Turner 50-ton upstroke press is a self-contained hydraulic press designed specifically for compression moulding of plastics. Because the design has not been governed in any way by previous models or by the necessity to incorporate components already in production, the designers claim to have produced a press greatly superior in efficiency and appearance to any competitive product in its class. It is well known that operation of presses from a central hydraulic system has many drawbacks, particularly with regard to control of pressure, but the hydraulic system used in the Turner press has advantages not found in other self-contained systems. We congratulate the makers on this simple and beautiful design.

(1) The Main Frame

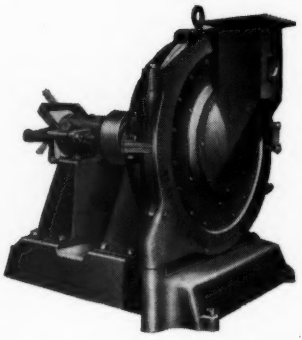
The main frame, instead of the usual round steel columns, consists of heavy steel plates welded together for rigidity, bevelled on the inner faces to guide the moving platen and fixed at the top and bottom respectively to the press head and cylinder base. The bearing areas for the head and base are large and both are provided with very deep and substantial ribs. The press unit is mounted directly on a welded steel tank within which the complete hydraulic system is contained.

(2) Hydraulic System

The unique hydraulic system of the Turner press incorporates a Turner automatic variable delivery high-pressure oil pump, driven directly by an electric motor running at 1,425 r.p.m. The low power of this motor, which is ample for the duty, indicates the economy of operation. The maximum capacity of the press is 50 tons and the pump pressure required to give this force is approximately 2,500 p.s.i. Although the maximum pump delivery is only 1½ gallons per min., both high and low speeds of ram operation are obtained by a patented system. The pump is of the radial type with seven pistons giving 10,000 impulses per min. and thus ensuring a steady pressure. Whenever the predetermined maximum pressure is reached the pump automatically moves to a no-stroke position, thus maintaining only sufficient delivery to make up any small leaks in the system or to follow up the flow of material in the mould just before the curing period commences.



A GREAT STRIDE FORWARD !



A NEW standard in fast grinding has been set by the GARDNER latest High-Speed Attrition Mill. This revolutionary machine effects perfect reduction in far less time and at less operational cost. Built to GARDNER'S traditional high level of workmanship and material, it will run day in, day out, with that freedom from trouble that is a characteristic of all GARDNER machines. Write for full particulars.

GARDNER

HIGH SPEED ATTRITION GRINDING MILL

LONDON:
19, Gray's Inn Chambers,
20, High Holborn, W.C.1.
Telephone - Chancery 7347.

WM. GARDNER & SONS (Gloucester) LTD.,
BRISTOL ROAD, GLOUCESTER.
Telephone: Gloucester 2288 (3 lines). Telegrams: "Gardner, Gloucester."

STEERING BALLS

to the specific requirements of our customers

Makers of all types of repetition products from the bar in all metals

M·C·L and REPETITION LTD.
Pool Lane · Langley · Birmingham

JACK L. BARNETT LTD.
12, MEADOW LANE, LEEDS 11. TEL.: 28004/5

WISH TO CONTACT MANUFACTURER INDUSTRIAL & DOMESTIC PLASTICS WITH VIEW POST-WAR SELLING ARRANGEMENTS. FINEST CONTACTS IN THE COUNTRY. LARGE WAREHOUSING PREMISES AVAILABLE. GOOD IDEAS FOR FUTURE LINES. FINANCIAL SUPPORT CAN BE GIVEN IF REQUIRED. ALL REPLIES HELD IN THE STRICTEST CONFIDENCE.

AGENCIES WANTED

AGENT with excellent connection amongst wholesalers and multiple stores, wishes to represent manufacturer of plastic products. Sole agency preferred. Box No. 5843, c/o "PLASTICS." 98/x7564

AGENTS with West-end and City premises desire contact manufacturers, goods and machinery. Box No. 22, c/o **SMITH'S BOOKSHOP**, Putney. 98/4382

BRITISH AGENT, established over 25 years in the Argentine, seeks agency—highest references and credentials. Box 241, c/o NATIONAL PUBLICITY CO., 43-44, Shoe Lane, London, E.C.4. 98/7

EXPERIENCED MEMBER Incorporated Sales Managers Association, 14 years' selling experience, seeks contact with manufacturers of high quality plastic products with a view to sole agencies covering London area. Articles of interest are those of: 1, unique application; 2, metal substitutes; 3, artistic appeal. Industrial, packaging or wholesale markets. Buying, commission or other suitable arrangements, offices and/or showroom now being negotiated. Box No. 6074, c/o "PLASTICS." 99/x8344

EXPORT. Firm with connections and selling organisation in almost every country desires to contact firms who are interested in establishing a sound export trade. SALES & PARTNERS, LTD., 7, Victoria St., Westminster, S.W.1. 'Phone: ABBEY 2089. 98/4258

EXPORT. Plastics expert, resident in France, with thorough knowledge of French and other continental markets, wishes to represent British manufacturers. Please write "E.P.E." c/o DIXONS, 43, Gt. Marlborough St., London, W.1. 98/2

PATENTS

THE PROPRIETOR of British Patent No. 534,439 for "Improvement in means for attaching fragile bodies to a support" desires to enter into negotiations with a firm or firms for the sale of the patent, or for the grant of licences thereunder. Further particulars may be obtained from MARKS & CLERK, 57 and 58, Lincoln's Inn Fields, London, W.C.2. 98/6

PRODUCTION CAPACITY AVAILABLE AND WANTED

CAPACITY AVAILABLE on EL9 Injection Moulding Machine. Only enquiries from firms with own moulds can be considered. Box No. 6115, c/o "PLASTICS." 98/x8440

EXPERT MOULD MAKERS have immediate capacity available for all types of plastic moulds, early delivery. Box No. 5933, c/o "PLASTICS." 98/x7870

INJECTION MOULDING CAPACITY wanted. Long runs, good price, regular work. Box No. 1894, SAMSON CLARK8, 57-61, Mortimer St., W.1. 98/3

THERMOSETTING MOULDINGS. Advertiser is interested to contact plastic moulders to produce a number of articles for export and home trade. Box No. 5907, c/o "PLASTICS." 99/4535

SITUATIONS VACANT

None of the vacancies under this heading relates to a man between the ages of 18 and 50 inclusive or a woman between 18 and 40 inclusive unless he or she is excepted from the provisions of the Control of Engagement Order, 1945, or the vacancy is for employment excepted from the provisions of that Order.

JIG AND FIXTURE DESIGNERS urgently required by large Plastics Company in N.E. London. Applicants should have had previous experience preferably in the plastics industry, and should write in the first instance stating qualifications, age and salary required, to Box No. 6422, c/o "PLASTICS." 98/5

MANAGER, storekeeper and order clerk wanted for plastic and photographic material business. LLOYD'S 72, Bridge St., Christchurch. zzz/49

MOULD DESIGNER, aged 20/30, with previous experience in the designing of moulds for compression and Injection moulding, to join a large organization who are developing a plastics department. Full details of experience, salary required, to Box No. 6423, c/o "PLASTICS." 98/8

PROCESS CHEMIST, with experience compression and injection moulding and extrusion. Full details, qualifications, experience, to Box No. 6424, c/o "PLASTICS." 98/9

PRODUCTION AND MATERIAL CONTROL. Senior and fully experienced man required for plastics industry. A.C.W.A. standard planning, estimating and labour audit included. Knowledge and experience of time study an advantage. Reply stating full details of career, age and salary required to Box No. 5909, c/o "PLASTICS." 98/1

PRODUCTION ENGINEERS urgently required by large Plastic Company in N.E. London. Applicants should have had previous experience, preferably in the plastics industry, and should write in the first instance stating qualifications, age and salary required, to Box No. 6421, c/o "PLASTICS." 98/4

WORKS MANAGER REQUIRED for small plastics firm, Camden Town district, with knowledge of the actual manufacture of umbrella handles, toilet goods, fancy goods made of sheeting and rod of celluloid, cellulose acetate, perspex, casein, etc., etc. Profit share if suitable after 6 months. Box No. 6436, c/o "PLASTICS." 98/x9165

SITUATIONS WANTED

PLASTICS ENGINEER, 18 years with large well-established moulding firm, desires progressive situation. Complete knowledge of design and production methods of compression, transfer and injection moulds. Fully competent to hammer rough designs into moulding propositions. Box No. 5813, c/o "PLASTICS." 98/x7523

WANTED

ACETATE AND NITRATE sheet off-cuts and scrap urgently wanted for work of National importance. We pay top prices. LLOYD'S, 72, Bridge Street, Christchurch, Hants. 'Phone: Christchurch 504. zzz/45

CELLULOSE ACETATE SCRAP AND OFFCUTS wanted to purchase. ALKAN CHEMICALS LTD., 20a, Hendon Lane, London, N.3. 98/3956

PLASTICS PRODUCTION. Advertiser wants commercial and technical advice towards the establishing of a plastics factory. Payment in cash or by co-operation in the factory. Adviser (individual or company) must have wide practical experience. Box No. 5904, c/o "PLASTICS." 99/10

PLASTIC RAZORS. Large quantities of Plastic Razors required for export and home sale. Box No. 5906, c/o "PLASTICS." 99/4534

REQUIRED, simple process for applying plastic "skin" on ornaments. Box No. 5889, c/o "PLASTICS." 98/x7783

WANTED. Modern Extruder, 4½" diameter, steam-heated, stainless steel, suitable for plastic extrusion. Box No. 5891, c/o "PLASTICS." 98/x7782

WANTED. Rubber Extruders, all sizes. Box No. 5890, c/o "PLASTICS." 98/x7782

MISCELLANEOUS

ACETATE OFF CUTS urgently required, 2, 3 or 4 millimetres; minimum size, 2" x 5". Box No. 6116, c/o "PLASTICS." 98/x8441

FACTORY TIME RECORDERS. Service rental. Phone, Vigilant 4731. TIME RECORDER, SUPPLY & MAINTENANCE CO., 28, Mayfield Rd., Sutton, Surrey. 101/3531

IMPREGNATION and coating of fabrics and papers. Also cutting and reeling, all expertly done by THE "TRANSPHOP" PAPER CO., Purley Way, Croydon. Telephone CROydon 6157. 104/3954

MONOMARKS. Permanent London Address. Letters redirected. 5/- p.a. Write MONOMARK BM/MONO76, W.C.1 98/3952

MOULDS.—Grained embossing plates and rollers. J. MARTIN & SONS, LTD., Ardwick, Manchester, 12. 98/3170

PLASTIC WASTE. Customers' materials sorted and ground to any mesh, however fine, including all thermoplastics. Six factories, fully equipped. DOHM LTD., 167, Victoria Street, London, S.W.1. 98/3955

POST-WAR TRADE WITH EIRE. If you are interested in extending your export trade the Advertiser's Company is in a position to advise on the prospects of marketing your products in Eire, and also acting as your selling organization. Long established connection with firms of International reputation. Goodwill with security is at your service. Reply Box No. 194, DORLAND, 18, Regent Street, London, S.W.1. 100/4175

PULVERISING AND GRADING. Reduction of most thermoplastics down to 200 mesh undertaken by DOHM LTD., 167, Victoria Street, London, S.W.1. 108/4533

SHORTHAND in 1 week. Test lesson 3d. DUTTON'S, (P.X), 92, Gt. Russell Street, W.C.1. zzz/47

SIR WILLIAM CRAWFORD & PARTNERS, LTD., Industrial Designers, undertake design and styling of new products or machines. Working prototypes made if required. 233, High Holborn, W.C.1. Tel.: Hol. 4381. zzz/50

Printed in England and Published Monthly by the Proprietors, TEMPLE PRESS LTD., BOWLING GREEN LANE, LONDON, E.C.1.

Tullis Russell & Co. Ltd.

Makers of

BASE PAPERS

for the

PLASTICS INDUSTRY

●

AUCHMUTY & ROTHES PAPER MILLS

MARKINCH, SCOTLAND

LONDON
1 Tudor Street, E.C.4

MANCHESTER
372 Corn Exchange Buildings
Corporation Street

BIRMINGHAM
116 Colmore Row

Reg'd. Trade Mark

JULY, 1945. Vol. IX. No. 98 **Plastics** ONE SHILLING & SIXPENCE

LASSO is making a mark for itself

Lasso Self-Adhesive Tape solves all your marking problems. These brilliant filmic markers can be cut off to length desired, are easy to apply, are ever-legible and are impervious to heat and fluids.

Supplied in 10-yard rolls or individual labels in colours to B.S. Specification and in shades matched to customers' requirements. Any type of wording, lettering or diagram produced.

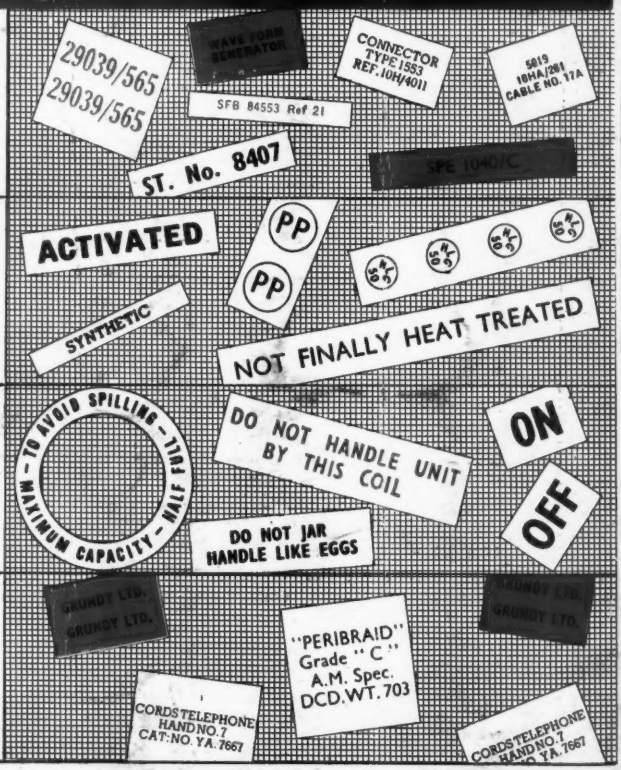
TYPICAL USES

IDENTIFICATION : Numbering of parts to simplify assembly of complicated circuits. Stores reference numbers, etc.

INSPECTION : Facilitates inspection by indicating treatment of components.

INSTRUCTIONS : Labels with full details for assembly work or finished components.

NAME TAPES : Ideal for sealing and labelling packages or finished components with your name.



Full details from CABLE ASSEMBLIES LTD., (Subsidiary of Herts Pharmaceuticals Ltd.)
BESSEMER ROAD, WELWYN GARDEN CITY
Telephone : Welwyn Garden 3333/6 *Telegrams :* Cablsembly, Welwyn Garden City